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CONNECTICUT RIVER

CONNECTICUT - MASSACHUSETTS

NAVIGATION STUDY

7458

THE BOARD OF ENGINEERS
RIVERS AND

827 (Conn. River, Conn. & Mass.)
Sec. 4

SURVEY REPORT

LONG ISLAND SOUND TO HOLYOKE, MASS.

(TEXT)

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U. S. ARMY
BOSTON, MASS., JUNE 3, 1949

TABLE OF CONTENTS

TABLES

PLATES

APPENDICES
(Separate Volume)

SURVEY REPORT ON CONNECTICUT RIVER

BETWEEN

LONG ISLAND SOUND AND HOLYOKE, MASSACHUSETTS

SYLLABUS

The Division Engineer submits a report on a study of further improvement of the Connecticut River for navigation between its mouth at Long Island Sound and Holyoke, Massachusetts.

Investigation has disclosed that the needs of navigation can be met by providing a channel 16 feet deep from the mouth of the river to Hartford, Connecticut, and 12 feet deep from Hartford, Connecticut, to Holyoke, Massachusetts.

The recommended improvement lends itself to stage construction. Between the mouth and Hartford, the channel can be obtained by dredging, and between Hartford and Holyoke, the channel can best be obtained by dredging and canalization of the river by the construction of a dam and lock at Enfield Rapids. Investigation has also disclosed that it will be advantageous to provide a hydroelectric power development in conjunction with the proposed dam at Enfield Rapids since the power so developed will be of economic benefit to the area.

The Division Engineer recommends that the existing projects be modified to provide a 16-foot channel, 300 feet wide, from Long Island Sound to the railroad bridge at Old Saybrook, thence, 200 feet wide to Hartford, Connecticut, with anchorage areas of the same depth at five locations; a 12-foot channel, 100 feet wide, from Hartford, Connecticut, to Holyoke, Massachusetts, with a turning basin at the upper end; a dam at Enfield Rapids, having a crest at elevation 45.0 feet, a navigation lock, and a hydroelectric power plant having installed capacity of 42,000 kilowatts; at an estimated cost of $31,925,000 for new work, and $426,500 annually for maintenance and operation, all subject to certain conditions of local cooperation.

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON, MASS.

June 3, 1949

SUBJECT: Survey Report on Connecticut River from Long Island Sound to Holyoke, Massachusetts.

TO: The Chief of Engineers, Department of the Army, Washington 25, D. C.

AUTHORITY

1. This report, on the Connecticut River between its mouth and Holyoke, Massachusetts, is submitted pursuant to the following authorities:

a. Section 7 of the River and Harbor Act approved July 24, 1946, Public Law 525, 79th Congress, which provides as follows:

> "The Secretary of War is hereby authorized and directed to cause preliminary examinations and surveys to be made at the following-named localities, * * * * Connecticut River, Connecticut."

b. Resolution adopted January 3, 1947 by the Committee on Rivers and Harbors of the House of Representatives, United States, as follows:

> "Resolved by the Committee on Rivers and Harbors of the House of Representatives, United States, That the Board of Engineers for Rivers and Harbors be, and is hereby, requested to review the reports on Connecticut River between Hartford, Connecticut, and Springfield and Holyoke, Massachusetts, submitted in House Document Numbered 165, Seventy-sixth Congress, First Session, with a view to determining if it is advisable to modify the existing project or change the recommendations in the aforesaid report in any way at this time."

SCOPE OF SURVEY

2. Pursuant to the authorization contained in the River and Harbor Act of July 24, 1946, the Chief of Engineers, by letter dated July 31, 1946, assigned a study of preliminary examination scope to the Division Engineer. Under this authorization a public hearing was held on November 26, 1946, and studies initiated. Acting on the authority contained in the Resolution dated January 3, 1947, the Chief of Engineers, on January 28, 1947, directed the Division Engineer to make a review study of survey scope of that

portion of the Connecticut River between Hartford, Connecticut, and Springfield and Holyoke, Massachusetts, and also directed that the preliminary examination authorized by the Act of July 24, 1946, be combined with the survey.

3. The report published in House Document Number 165, 76th Congress, 1st Session, dated February 15, 1939, recommended that the existing project for navigation between Hartford and Holyoke be modified to provide for the construction, at Federal expense, of a dam, lock and power house at Enfield, and to provide a 12-foot deep navigation channel. Hearings on this report were held by the Committee on Rivers and Harbors of the House of Representatives, but no further action on the report has been taken by Congress.

4. Investigations for Current Study. - Hydrographic surveys of the river from the mouth to Hartford, made for maintenance purposes, were used as were probing data in that section, developed in 1932 for the report published in House Document Number 49, 73rd Congress, 1st Session. For the section of the river from Hartford to Holyoke, hydrographic surveys made in 1937 and earlier years were used. Probing data for this section of the river used in earlier reports were also utilized, supplemented by additional data at the Enfield site obtained while the present study was in progress. Boring data at the site for the Hartford Dam and the Enfield site used in the report contained in House Document Number 165, 76th Congress, 1st Session, were used in this report. Topography obtained from previous surveys was used throughout.

5. Public Hearings. - Two public hearings were held as well as numerous conferences with State and municipal officials, and representatives of transportation and power interests. Frequent consultation and correspondence with the Regional Office of the Federal Power Commission and the Regional Office of the United States Fish and Wildlife Service were had on features concerning these agencies. An abstract of the information obtained at the hearings and conferences is contained in Paragraphs 39 to 54, inclusive.

DESCRIPTION OF THE CONNECTICUT RIVER BASIN

6. The Connecticut River rises in northern New Hampshire and the Province of Quebec and flows southerly along the border between the States of New Hampshire and Vermont and across the States of Massachusetts and Connecticut. It empties into Long Island Sound at Old Saybrook, Connecticut, about 14 miles west of New London and about 30 miles east of New Haven. The river is about 390 miles long and drains an area of 11,260 square miles. The drainage basin is long and narrow, the maximum width being only 62 miles. The White Mountains in New Hampshire on the north, and lower mountains and minor ridges extending south therefrom, form the eastern boundary of the

watershed. The western boundary of the basin is formed by the Green Mountains in Vermont, the Berkshire Hills in Massachusetts, and minor elevations to the south of Connecticut.

7. River Characteristics. - The river is tidal for a distance of about 60 miles. The mean range of tide is 3.4 feet at the mouth and about 1.2 feet at Hartford during low river stages. Spring freshets usually reach a height of from 16 to 24 feet at Hartford and from 10 to 15 feet at Springfield, above the respective mean low water stages. Freshet heights decrease rapidly below Middletown, the amount of decrease being less pronounced at high stages. The highest recorded flood occurred in March 1936, with heights of 35.6 and 26.2 feet above mean low water at Hartford and Springfield, respectively. Mean low water summer stage at Hartford is 2.0 feet on the gage referred to the Engineer Department datum, the zero of which is 0.55 feet below mean sea level. Data from the record of discharges of the river in cubic feet per second at Hartford are as follows:

Average	17,300
Maximum	289,000
Minimum	1,200

8. Navigation on River. - There is active commercial navigation between the mouth and Hartford, a channel 15 feet in depth being available in that section. Although at present there is no commercial navigation above Hartford, recreational boats use the river up to Holyoke. The controlling depth is 2.5 feet between Hartford and Windsor Locks, where a canal used mainly for power and process water affords navigation around the rapids. Controlling depths in the canal are about 3.0 feet in the lower lock and 6.0 feet in the canal proper, with 4.5 feet in the river between the canal and Holyoke. The principal tributaries between Hartford and Holyoke, the Farmington, Westfield, and Chicopee Rivers, are navigable for small boats for short distances above their points of confluence with the Connecticut River.

9. The portion of the river from the mouth to Hartford is shown on United States Coast and Geodetic Survey Charts 215, 266, and 267. The portion of the river from Hartford to Holyoke is shown on United States Geological Survey Quad Sheets for the Hartford and Springfield Quadrangles. The river is also shown on the map accompanying this report, Plate 1.

TRIBUTARY AREA

10. Population. - Bordering on the river between Long Island Sound and Holyoke are 28 towns and cities which had populations over 1,000 in 1940. Of these, those that had populations over 25,000 are Hartford, Connecticut, with 166,000; Springfield, Massachusetts, with 149,000;

Holyoke, Massachusetts, with 53,000; Chicopee, Massachusetts, with 41,000; and Middletown, Connecticut, with 26,000. The population that would be served by a navigation improvement north of Hartford to Holyoke is estimated at 660,000. The population now served by the existing improvement to Hartford is estimated at 500,000.

11. Development in the Tributary Area. - The Connecticut valley up to Holyoke, Massachusetts, is a rich farming and industrial region. The cities of Hartford and Middletown in Connecticut and Springfield, Chicopee, and Holyoke in Massachusetts are large industrial centers for the manufacture and distribution of paper, textiles, machinery, tools, metals, rubber products, and electrical goods. At Thompsonville, a village in the town of Enfield, Connecticut, there is a large carpet factory situated on the river bank. The Connecticut valley supports many large tobacco-growing and general farms.

12. Highways and Railroads. - The Connecticut valley region is served with a network of fine roads and main line and branch railroads. The main line of the New York, New Haven, and Hartford Railroad between New York and Boston crosses the river near its mouth at Old Saybrook. A main branch line of this railroad extends to Middletown and Hartford, thence continues to Springfield, Massachusetts, thus offering connection to the Boston and Albany Railroad running east and west from Boston to Albany, and the Boston and Maine Railroad, which extends up the valley, to Holyoke, and thence to points in New Hampshire and Vermont and to Montreal in Canada. Numerous branch line railroads connect with the main lines at various points along the valley.

13. There are numerous overland trucking concerns operating in the valley. Many of these have terminals in the larger cities along the river. Bus lines operate over all of the main highways.

14. Oil Pipe Line. - There is a 6-inch pipe line used for transporting petroleum products extending from a refinery at a deep water terminal at Providence, Rhode Island, to Springfield, Massachusetts, and Hartford, Connecticut. The line is not used as a common carrier. Gasoline is the principal product transported through the line, with some kerosene, and light fuel oil.

BRIDGES

15. Twelve highway and five railroad bridges cross the river between the mouth and Holyoke. Ten of the highway and three of the railroad bridges are fixed bridges, one each of the highway and railroad bridges are of the bascule type, and one each are of the swing type. Table No. 1 in Appendix I shows the location, ownership, type, and clearance of each bridge.

16. The bridges that would be affected by the plans of improvement considered in this report are listed in Table No. 11.

OBSTRUCTIVE UTILITIES

17. Overhead Utility Crossings. - At seven locations, aerial wires, all used for the transmission of power, span the Connecticut River within the limits of the project under study. Four of these overhead crossings are located between the river's mouth and Hartford, Connecticut; and three located between Hartford, Connecticut, and Holyoke, Massachusetts. Appendix I gives the ownership, type, and clearance of each structure. None of these crossings would interfere with any navigation that can be reasonably expected to use the river.

18. Underwater Utility Crossings. - There are 22 locations at which underwater utilities cross the Connecticut River in the reach from the mouth to Holyoke, Massachusetts. At many of these locations several utilities cross at the same mile point. In addition, there are many cases of utilities having been abandoned within this portion of the river, some of which are reported to have been removed and others left in place as they were buried deep in trenches across the bed of the river. Of the 22 crossings mentioned, 14 are below Hartford and 8 above. From the records on file the least depth over the submarine structures is about 18 feet at mean low water from the mouth to Hartford. Of the 8 crossings above Hartford, 7 are to a least depth of 13 feet and 1 is at a 10-foot depth. Appendix I gives data relative to each of these crossings. The submarine utilities which would be affected by the plans of improvement considered in this report are listed in Table No. 12.

PRIOR REPORTS

19. There have been many reports on the Connecticut River relative to its improvement for commercial navigation. In general, these reports have covered: (a) improvements at particular localities or bars on the Connecticut River; (b) improvement for commercial navigation to Hartford; and (c) improvement for commercial navigation above Hartford. The earliest report on the Connecticut River was made in 1837, which recommended the dredging of a channel 500 feet wide, 12 feet deep over the Saybrook bar at the mouth of the river. Since 1900, the following reports have been made:

Year	Document Number	Congress & Session	Nature of Report
1911	H. Doc. 1294	61/3	Recommended dredging Saybrook bar 300 feet wide, and 15 ft. deep; channel bars to Hartford 100 ft. wide and 12 ft. deep; and dikes, training walls and revetments. Adopted by R & H Act Feb.27, 1911.
1913	H. Doc. 1225	62/3	Preliminary examination on Wethersfield Cove, Connecticut. Unfavorable.
1915	H. Doc. 417	64/1	Recommended 12-ft. channel from Hartford to Holyoke, subject to local interests constructing new dam and lock at Enfield. No action by Congress.
1916	H. Doc. 1016	64/1	Preliminary examination on Sebethe River, Connecticut. Unfavorable.
1917	H. Doc. 132	65/1	Recommended additional dikes, training walls, revetments and accessory works. Adopted by R & H Act Mar. 2, 1919.
1925	R.& H. Comm. Doc. 11	68/2	Recommended 7-ft. channel from Hartford to Windsor Locks Canal, subject to local interests contributing 50% of first cost and minor conditions. No action by Congress.
1930	R.& H. Comm. Doc. 35	71/2	Reviewed H. Doc. 417 and recommended no improvement by United States.
1930	R.& H. Comm. Doc. 36	71/2	Reviewed R. & H. Comm. Doc. No. 35 and recommended 12-ft. channel from Hartford to Holyoke, subject to condition that private interests construct a new dam and lock at Enfield. Project adopted by R.& H. Act of July 3, 1930.
1932	H. Doc. 49	73/1	Recommended 15-foot channel to Hartford and additional regulatory works. Adopted by R. & H. Act of Aug. 30, 1935.

Year	Document Number	Congress & Session	Nature of Report
1933	H. Doc. 27	73/1	Reviewed report in R. & H. Comm. Doc. No. 36. Recommended no change in existing project above Hartford except that the condition with respect to the lock and dam at Enfield Rapids be broadened to provide for such construction by State, municipal or private interests. Recommendation adopted by R. & H. Act of Aug. 30, 1935.
1936	H. Doc. 412	74/2	Prepared pursuant to H. Doc. No. 308, 69th Congress, 1st session. Recommended no modification of the approved project for navigation.
1937	Letter from Secretary of War dated Apr. 21, 1937 (Not published)	-	Stated that War Department would not object to declaring Park River non-navigable. Park River declared non-navigable by special act approved May 24, 1937.
1939	H. Doc. 165	76/1	Recommended modification of existing project to provide for construction of combined navigation and power dam at Enfield by the Federal Government and alteration of bridges by local interests. No action by Congress.
1939	H. Doc. 368	76/1	Recommended anchorage area at North Cove in Town of Saybrook, Conn., 29 acres of 11-and 6-ft. depth with 11-ft. entrance channel. Adopted by R. & H. Act of Mar. 2, 1945.
1941	Not printed	-	Considered channel between Hartford and Holyoke for vessels of light draft. Unfavorable.
1948	H. Doc. 666	80/2	Recommended modification of project below Hartford to include 8-foot channel in Eightmile River with turning basin and 6-foot anchorage, 6.5 acres, at Hamburg. No action by Congress.

In addition to the foregoing there have been several reports during the past twenty years pertaining to flood control measures at communities between Hartford and Holyoke.

20. Basis of Existing Projects. - Of the foregoing reports four are of special interest in connection with the present report. The report contained in House Document No. 49, 73rd Congress, 1st Session, is the basis for that part of the existing project having to do with the dredged channel from the mouth of the river to Hartford. The reports contained in Committee on Rivers and Harbors Document No. 36, 71st Congress, 2nd Session, and in House Document No. 27, 73rd Congress, 1st Session, are the basis for the existing project for that section of the river between Hartford and Holyoke. No work has been undertaken on this project. In the report contained in House Document No. 165, 76th Congress, 1st Session, the Chief of Engineers recommended that the existing project for improvement above Hartford be modified to provide for construction of the dam, lock and power plant at Enfield by the Federal Government, and for a vertical clearance under bridges of 20 feet at a river stage corresponding to 16 feet at Hartford.

EXISTING CORPS OF ENGINEERS' PROJECTS

21. Early Channel Improvements. - Improvement for navigation on the Connecticut River may be divided into that work done below Hartford, Connecticut, and that above Hartford. Federal improvement of the lower river began in 1836 when, during that and subsequent years to 1843, a channel 11 to 12 feet deep was dredged through the bar at the mouth. No further work was done until 1871. Under projects approved in 1870 and subsequently modified in 1873, 1880, 1888, and 1899, parallel jetties were constructed at the mouth of the river, low training walls were built at Hartford and Glastonbury (the Hartford wall being later raised to its present height) and channels were dredged through the outer (Saybrook) bar and through the bars in the river. The channel dimensions on Saybrook bar were increased progressively to 15 by 300 feet. In the river the bars were first dredged 100 feet wide and 8 feet deep but now have a depth of 15 feet with a width of 150 feet. Regulatory works in the channel have been constructed under authorizations dated 1911, 1919, and 1935. The Chief of Engineers, in House Document No. 666, 80th Congress, 2nd Session, has recommended the project be modified to include in the Eightmile River the existing channel, 8 feet deep and 75 feet wide, and turning basin at Hamburg, 150 feet wide and 300 feet long and a proposed 6.5 acre anchorage 6 feet deep.

22. Navigation Channel Below Hartford. - The existing project for the Connecticut River below Hartford provides for a channel 15 feet deep at mean low water, 300 feet wide from the mouth to the Lyme railroad bridge, and thence upstream 150 feet wide to Hartford, a total distance of 52 miles. The channel has been obtained by dredging, and construction of dikes,

training walls, revetments, and the accessory works, including two riprap jetties at the mouth of the river. The channel excavation was completed in 1937, but additional regulatory works are required to stabilize the channel.

23. Small Boat Anchorage at North Cove. - The existing project below Hartford also provides for a small boat anchorage in North Cove, a tributary water of the river near the mouth at Old Saybrook. The anchorage would have an area of about 12 acres with a depth of 11 feet and about 17 acres with a depth of 6 feet, together with a channel 100 feet wide and 11 feet deep leading to it from the channel in the main river. No work has been undertaken on these improvements.

24. Summary of Costs of Project Below Hartford. - The costs to June 30, 1948 under the existing project below Hartford were $849,555.98 for new work, and $1,554,715.54 for maintenance, a total of $2,404,271.52. The total costs to the United States of work below Hartford were $1,136,930.27 for new work, and $1,921,064.01 for maintenance, a total of $3,057,994.28. The present approved annual maintenance cost revised in 1948, is $87,000.

25. Project Above Hartford. - Above Hartford, minor Federal navigation improvements were made between 1871 and 1914, but under no particular plan. Six low wing-dams were built and a small amount of dredging was done below Enfield Rapids. One of the wing-dams has since been removed.

26. The existing project above Hartford was adopted by the River and Harbor Act of July 3, 1930, and modified by the act of August 30, 1935. The act of 1930 authorized improvement subject to the following limitations:

> " Connecticut River, above Hartford, Connecticut: There is authorized to be expended upon the project reported by the Chief of Engineers under date of April 24, 1930, and printed in the Rivers and Harbors Committee Document Numbered 36, Seventy-first Congress, second session, subject to the conditions set forth in said report, the sum of $1,000,000, and subject to the further conditions that the Bulkley, or Memorial, Bridge across the Connecticut River at Hartford shall not be disturbed, and that the lock and dam described in the report as to be built near the city of Hartford shall not be constructed so near said city as to in any way disturb city improvements or otherwise interfere with the said city."

27. Document No. 36, which formed the basis of the above authorization, provided for the improvement recommended by the District Engineer in his report printed in Rivers and Harbors Committee Document No. 35, 71st Congress, 2d session, subject to the following conditions:

> " (a) The construction shall not begin until the Secretary of War shall be satisfied: (1) that the work at Enfield Rapids under license issued by the Federal Power Commission will be completed; (2) that the bridges will be modified to provide free, easy, and unobstructed navigation as required under existing law, and that such modification will be completed substantially at the same time as the work on the improvement; (b) that the cities of Springfield, Holyoke, and Chicopee shall make suitable provision for terminal facilities satisfactory to the Secretary of War."

The improvement recommended by the District Engineer in Document No. 35 provided for a channel from Hartford to Holyoke, about 32.5 miles, 12 feet deep at mean low water, summer stage, with an increase in depth of 1.4 feet through Enfield pool, and generally 100 feet wide, to be secured by the construction near Hartford of a lock and dam, the construction at Enfield of a dam and of a lock of limited size by private interests, the lengthening of the latter lock by the United States, and by channel dredging and construction of suitable regulatory works, all at a total estimated cost of $3,384,000, with $85,000 annually for maintenance and operation. The locks then proposed were to be 45 feet wide by 310 feet long in the clear, with 15-foot depth of water over the sills. The normal lift at Hartford lock was about 7 feet and at the Enfield lock about 30 feet.

28. The act of August 30, 1935, mentioned in Paragraph 26, authorized improvements in accordance with the plans recommended in House Document No. 27, 73d Congress, 1st Session, which stated:

> "No change is advisable in the project * * * as authorized by the River and Harbor Act of July 3, 1930, in accordance with the report published in House Committee Document No. 36 (71st Cong. 2d sess.), subject to the conditions set forth in the report and in the act of authorization except that the condition with respect to the construction of the lock and dam at Enfield Rapids be broadened to provide for such construction by State, municipal, or private interest under license issued by the Federal Power Commission."

29. Since the conditions with respect to construction of the lock and dam at Enfield Rapids have not been met, and as there is no indication that they will be met, no work has been undertaken by the United States, and no appropriation has been made. The Chief of Engineers has recommended the construction of the lock, dam, and power house at Enfield by the United States, in House Document No. 165, 76th Congress, 1st session.

30. Summary of Costs, Project above Hartford. - There have been no costs to the United States under the existing navigation project between Hartford and Holyoke. Under previous projects costs to the United States were $116,324.81 for new work, and $14,373.54 for maintenance, a total of $130,698.35.

REQUIREMENTS OF LOCAL COOPERATION UNDER EXISTING PROJECTS

31. Project below Hartford. - The conditions of local cooperation under the existing project for the improvement of the Connecticut River from the mouth to Hartford for navigation are set forth in the River and Harbor Act of August 30, 1935 which authorized the 15-foot channel up to Hartford and related regulatory and training works. These conditions are that local interests furnish, free of cost to the United States, suitable areas for the disposal of dredged material during initial construction and for future maintenance as and when required. The use of meadow land adjacent to the river for revetment work has been granted and spoil areas furnished when required.

32. Project above Hartford. - The conditions of local cooperation under the existing project for the improvement of the Connecticut River above Hartford to Holyoke are set forth in the preceding Paragraphs 27 and 28. The condition that requires the dam at Enfield Rapids be constructed by local interests under license to be issued by the Federal Power Commission has not been met, although at the time the project above Hartford was authorized the Northern Connecticut Power Company held such a license issued February 1, 1928. However, as the company failed to proceed with the work, the license was terminated on September 30, 1931, and no subsequent application has been made.

OTHER IMPROVEMENTS

33. In the early development of Central New England, freight was moved on the Connecticut River in small boats of light draft to and from points more than 200 miles above the mouth.

34. Improvements below Hartford. - Improvement of the river was commenced early in the nineteenth century in the section below Hartford, and was continued periodically by users of the river until dredging was undertaken by the United States. Since that time, local interests have dredged in waters tributary to the river and occasionally in the main river. The cost of these improvements is unknown.

35. Improvements above Hartford. - Above Hartford, at several of the rapids, dams and navigation canals were constructed by private interests including those at Enfield Rapids. The facilities at Enfield Rapids, constructed between 1824 and 1831, supply water for process and power purposes to six industries and provide for passage of small boats around the rapids through the locks and canal. There are similar facilities at Holyoke and Chicopee, except that there is no provision for navigation.

36. Private interests have undertaken minor dredging between Hartford and Springfield in an effort to revive water transportation.

EXISTING AND REQUIRED TERMINAL AND TRANSFER FACILITIES

37. Below Hartford. - The principal landings and terminals are at Saybrook, Middletown, Portland, Cromwell, Hartford, and East Hartford. All of these are privately-owned commercial wharves. Several oil terminals along the river are equipped with complete facilities for handling petroleum products in bulk. The wharf of the Hartford Electric Light Company at Hartford, to which a large part of the coal handled on the river is delivered, is equipped with coal handling and storage facilities. At Hartford, a municipally-owned wharf with a frontage of about 1500 feet is available for public use. This wharf is located on the river side of a high concrete flood wall constructed by the United States and is now in poor condition. There is no rail connection to this wharf. Alteration to the flood protective dikes and walls would be required before rail connections could be provided to a large part of the river frontage at Hartford and East Hartford. There are five yacht clubs located along the river between the mouth and Hartford, and 13 yards for the repair and storage of small boats, as well as other small landings open to the public at three locations. The existing facilities appear to be sufficient for present needs and there is ample river front available for further development when needed.

38. Above Hartford. - Above Hartford, Connecticut, to Holyoke, Massachusetts, there are no terminal or transfer facilities. The Springfield Gas Light Company maintained a bulkhead with a rail connection to serve light-draft vessels used for local marine work prior to the construction of the concrete flood wall. Springfield, Chicopee, and Holyoke, Massachusetts, would require waterfront terminals if commercial navigation was developed to these localities. Ample frontage is available for this purpose and the cities have indicated a willingness to build them under the existing project. As potential tonnages would be principally coal and petroleum products, the development of the waterfront facilities need not be extensive. The Springfield Yacht and Canoe Club is located on the west bank of the river in Agawam, just below the South End Bridge. Gasoline and supplies are available there. There are also two boat yards in this section of the river which have storage and repair facilities.

IMPROVEMENT DESIRED BELOW HARTFORD

39. A public hearing at Hartford, Connecticut, on November 26, 1946, held to ascertain the view of local interests on the improvement of Connecticut River, Connecticut, was attended by public officials, individuals and officials of civic organizations, and representatives of business enterprises interested in commercial navigation on the Connecticut River below Hartford. A majority of the actual users of the waterway expressed the belief that some modification should be made to the existing project below Hartford. A few expressed themselves as being satisfied with the channel dimensions as now authorized, but urged that it be maintained to full dimensions at all times and widened at bends. A representative of an independent oil company suggested an enlargement of the channel below Hartford to accommodate ocean-going tankers and cargo vessels.

40. Views of Carriers of Petroleum Products. - Some of the owners of vessels carrying petroleum products presented facts pertaining to type, size, and carrying capacity of their vessels in support of their position relative to channel requirements. One owner stated that from January 1 to November 15, 1946, his company delivered 547,295 barrels of oil and gasoline to terminals of major and independent oil companies located on the Connecticut River, in self-propelled vessels having loaded drafts of eleven to twelve feet. This owner stated that two larger vessels having drafts of 14 feet, 6 inches, and 13 feet, 6 inches, each having a capacity of 10,000 barrels, owned by his company, could operate on the river if the channel was deepened to sixteen feet. This owner made the following recommendations for improving navigation conditions on the Connecticut River:

> a. That the channel from Saybrook to Hartford be deepened to sixteen feet and widened to a minimum of two hundred feet.
>
> b. That the bends at Brockway, Eddy Rock, Warners Quarry, Rock Landing, Mouse Island, Gildersleeve, Pistol Point, Two Piers Channel, Rock Hill Point, Glastonbury, Cys Hollow, and Clay Bank be widened.
>
> c. That anchorage with depths of sixteen feet be provided at Old Haddam, Cromwell, and Rocky Hill.

41. One of the major oil companies in requesting a modification of the channel stated that deliveries of its products are made to its terminal by company-owned vessels consisting of two tugs, each 98 feet in length, beam 25 feet, and draft 12 feet, 6 inches, and ten barges ranging in size from 175 feet to 210 feet in length, beam 40 feet and loaded drafts of 10 feet to 14 feet.

42. In a communication received shortly after the hearing, the Inland Water Petroleum Carriers Association requested widening on the bends to eliminate ice jams in the river as well as for the purpose of using larger boats.

IMPROVEMENT DESIRED ABOVE HARTFORD

43. A second public hearing was held at Bradley Field, Windsor Locks, Connecticut, on April 30, 1947, to obtain information on the views of local interests on the existing projects for navigation between the mouth of the river and Holyoke, Massachusetts, and on the recommendation contained in House Document No. 165, 76th Congress, 1st session, for the improvement of the river for navigation between Hartford, Connecticut, and Holyoke, Massachusetts. Views of both proponents and opponents were heard; the views of the latter group dealing, in most instances, with specific phases of the improvement.

44. Report of Massachusetts Commission. - Members of a Special Legislative Commission of the Commonwealth of Massachusetts spoke in favor of the improvement of the Connecticut River between Hartford and Holyoke for navigation, but offered no specific plans for the development of the river. The Commission was created by a Resolve of the Massachusetts Legislature, approved June 6, 1946, entitled, "Resolve providing for an investigation of the benefits to be derived from the opening of the Connecticut River to navigation between the cities of Hartford and Holyoke," and requiring that a report be submitted to the General Court, setting forth, "The results of its investigation and its recommendations, if any, together with drafts of such legislation as may be necessary to carry such recommendations into effect." The Commission's report was presented, in printed form, to the General Court under date of December 3, 1946. No legislative action has been taken on this report.

45. The report of the Massachusetts Special Legislative Commission while offering no specific plan for the development of the river from Hartford to Holyoke favors the plan designated as "Plan F" in House Document Numbered 165, 76th Congress, 1st session, which included dams and locks at Hartford and Enfield, with a power development at Enfield. The Commission's report discusses benefits to be derived from transportation by water, if a navigable channel to Holyoke were provided, of petroleum products, bituminous coal, fertilizer, wood pulp, and other commodities. On the basis of a survey of potential river traffic, it was estimated that savings in transportation costs would be between $3,500,000 and $4,000,000 annually. The quantities of commodities on which this estimate was based; and the comparative rail, truck, and water transportation costs are not given in the report. The Commission considered that an entirely conservative estimate of possible transportation

savings would be $2,000,000 annually, which with additional benefits to be derived from the power plant, would amount to an annual total benefit of $2,593,000. The Commission concluded that such a project would be most valuable to the people of western Massachusetts and that anything which benefits one part of the State benefits all of the State.

46. Views of Upstream Interests. - The transportation representative of the Springfield Chamber of Commerce suggested that the opening of the river to navigation would offer competition that would have a stabilizing influence on transportation charges, and would very likely reduce them on such commodities as coal and oil. A representative of the mayor of the city of Springfield expressed approval of the project. A representative of the city of Holyoke favored improvements both from the standpoint of navigation and that of hydroelectric power development, and indicated that the city is interested in the power development as a prospective consumer.

47. The Traffic Manager of White and Wyckoff Manufacturing Company, Holyoke, Massachusetts, manufacturers of writing paper, expressed a belief that a power development only might be worthy of consideration, but that there was little possibility of developing sufficient traffic to justify navigation since the high cost of local handling of commodities would offset any savings accruing from barge transportation.

48. Views of Connecticut Interests. - The Manufacturers Association of Connecticut, on behalf of the owners of mills adjacent to the canal at Windsor Locks, voiced objection to the construction and operation of a power dam at Enfield on the grounds that power development would interfere with the taking of water from the existing canal for mill and power purposes.

49. The Connecticut Chamber of Commerce opposed the project on the grounds that the proposed waterway would not effect a savings in the transportation cost of coal and oil, and there was scant possibility of economic revival of the now extinct, but once important, passenger, and miscellaneous freight commerce on the river.

50. Oil Transportation. - A representative of the T. A. D. Jones and Company, a large dealer in petroleum products, particularly Bunker "C" fuel oil, and coal, with wharves, yards, and storage facilities at New Haven, stated that the company is in favor of any improvement which might extend its market. The company submitted data on transportation cost which indicated a doubt that the proposed improvement would result in savings in such costs. On the assumption that the project would not include provision for maintaining the channel free of ice during the winter and that sufficient storage capacity for a four-months supply at Springfield would be required, the company estimated that the cost of transporting Bunker "C" oil from New Haven to the consumer at Springfield would be 37 cents to 40 cents per barrel, barged from

New Haven, against 38.5 cents per barrel trucked from New Haven, and 37.3 cents shipped by rail from New Haven. The estimated cost by barging, however, included 10 cents per barrel for plant charges on a facility having four-months winter storage capacity.

51. The New York, New Haven and Hartford Railroad submitted a comparison of the then current prices of household fuel oil and gasoline at New Haven, Hartford, Springfield, and Holyoke to show there was only a fraction of a cent difference in the ultimate consumer price on these commodities in any of these cities. It was stated that prices in Springfield were evidently governed by the existing pipe line. The company contended that Springfield and Holyoke were not penalized because of the absence of waterborne transportation facilities and that there is no probability that river transportation would have any effect upon the relative prices to the ultimate consumer.

52. Coal Transportation. - A representative of The Hartford Electric Light Company pointed to the then comparatively small differential in rail and water transportation on coal. He expressed some preference for water transportation for handling fuel oil, but said that the then current price of fuel oil had increased to a point where coal was more economical to use and concluded that " all present conditions point to a lesser use of the river by us for fuel transportation purposes".

53. Power Development. - The Connecticut Light and Power Company presented testimony to the effect that at one time its predecessor, the Northern Connecticut Power Company, held a permit to develop the Enfield power site, but decided, after some study, that the project was uneconomic; and, in 1931, allowed the permit to lapse.

54. Subsequent to the hearings, that is in recent months, representatives of power companies operating in the Connecticut River Valley have informally indicated that their companies will have need of additional generating capacity within the next decade, and that the power that might be produced at a hydroelectric plant at Enfield could be readily absorbed in existing systems.

PAST AND PRESENT COMMERCE

55. The following table, Table No. 1, gives the comparative statement of water-borne commerce on the Connecticut River below Hartford during the 11-year period 1937 to 1947. There is no commerce reported on the river above Hartford.

(Table No. 1 on following page)

RECEIPTS

YEAR	ANTHRACITE	BITUMINOUS COAL	PETROLEUM PRODUCTS					FERTILIZER & FERTILIZER MATERIALS	LUMBER	ALL OTHERS	TOTAL
			GASOLINE	KEROSENE	LIGHT FUEL OIL	BUNKER C FUEL OIL	ALL OTHERS				
1937	30,475	170,333	396,450	146,796	315,595	115,053	1,433	11,998	406	9,375	1,19
1938	22,556	58,800	396,423	152,697	250,060	143,222	1,316	13,431	-	4,302	1,04
1939	24,697	78,618	435,593	174,916	272,107	204,019	1,363	12,350	-	1,387	1,20
1940	11,943	142,028	478,638	162,712	391,334	193,245	1,558	13,635	-	13,514	1,40
1941	10,253	145,609	490,162	170,486	334,836	340,788	1,044	16,717	-	19,809	1,52
1942	11,569	287,796	287,153	112,954	248,894	109,540	613	13,151	-	22,342	1,09
1943	10,260	224,213	248,408	88,756	179,822	89,910	52	5,394	-	25,550	87
1944	11,546	169,953	398,638	81,345	257,961	128,980	22	6,034	-	-	1,05
1945	12,185	214,865	390,463	107,104	252,796	130,108	-	6,511	-	508	1,11
1946	9,684	144,261	366,755	149,463	443,200	273,719	27	7,106	-	6,000	1,40
1947	8,919	194,025	370,832	132,229	572,042	235,593	15,328	7,237	-	38,424	1,57

SHIPMENTS

YEAR	PETROLEUM PRODUCTS	SCRAP METAL	FERTILIZER & FERTILIZER MATERIALS	ALL OTHERS	TOTAL SHIPMENTS
1937	428	33,168	980	146	34,722
1938	5	25,136	950	125	26,216
1939	198	31,360	1,020	-	32,578
1940	16	17,920	-	166	18,102
1941	1,435	840	-	6,676	8,951
1942	-	-	-	176	176
1943	1,563	-	-	14	1,577
1944	-	-	-	-	-
1945	1,652	-	-	-	1,652
1946	-	-	-	-	-
1947	20,101	-	-	9,696	29,797

GRAND TOTAL

RECEIPTS AND SHIPMENTS
1,232,636
1,069,023
1,237,628
1,426,709
1,538,655
1,094,188
873,942
1,054,479
1,116,192
1,400,215
1,604,426

Data on 1948 commerce are not available.

TABLE NO. 1 - COMMERCE ON CONNECTICUT RIVER BELOW HARTFORD IN TONS

RECEIPTS

YEAR	ANTHRACITE	BITUMINOUS COAL	PETROLEUM PRODUCTS					FERTILIZER & FERTILIZER MATERIALS	LUMBER	ALL OTHERS	TOTAL RECEIPTS
			GASOLINE	KEROSENE	LIGHT FUEL OIL	BUNKER C FUEL OIL	ALL OTHERS				
1937	30,475	170,333	396,450	146,796	315,595	115,053	1,433	11,998	406	9,375	1,197,914
1938	22,556	58,800	396,423	152,697	250,060	143,222	1,316	13,431	-	4,302	1,042,807
1939	24,697	78,618	435,593	174,916	272,107	204,019	1,363	12,350	-	1,387	1,205,050
1940	11,943	142,028	478,638	162,712	391,334	193,245	1,558	13,635	-	13,514	1,408,607
1941	10,253	145,609	490,162	170,486	334,836	340,788	1,044	16,717	-	19,809	1,529,704
1942	11,569	287,796	287,153	112,954	248,894	109,540	613	13,151	-	22,342	1,094,012
1943	10,260	224,213	248,408	88,756	179,822	89,910	52	5,394	-	25,550	872,365
1944	11,546	169,953	398,638	81,345	257,961	128,980	22	6,034	-	-	1,054,479
1945	12,185	214,865	390,463	107,104	252,796	130,108	-	6,511	-	508	1,114,540
1946	9,684	144,261	366,755	149,463	443,200	273,719	27	7,106	-	6,000	1,400,215
1947	8,919	194,025	370,832	132,229	572,042	235,593	15,328	7,237	-	38,424	1,574,629

SHIPMENTS

YEAR	PETROLEUM PRODUCTS	SCRAP METAL	FERTILIZER & FERTILIZER MATERIALS	ALL OTHERS	TOTAL SHIPMENTS
1937	428	33,168	980	146	34,722
1938	5	25,136	950	125	26,216
1939	198	31,360	1,020	-	32,578
1940	16	17,920	-	166	18,102
1941	1,435	840	-	6,676	8,951
1942	-	-	-	176	176
1943	1,563	-	-	14	1,577
1944	-	-	-	-	-
1945	1,652	-	-	-	1,652
1946	-	-	-	-	-
1947	20,101	-	-	9,696	29,797

GRAND TOTAL

RECEIPTS AND SHIPMENTS
1,232,636
1,069,023
1,237,628
1,426,709
1,538,655
1,094,188
873,942
1,054,479
1,116,192
1,400,215
1,604,426

Data on 1948 commerce are not available.

56. From the foregoing table it will be noted that during the period 1937 to 1941 the amount of commerce generally increased from year to year, followed by a sharp reduction during the war years and marked recovery in 1946. Substantial amounts of scrap metal were shipped from Hartford during the first five years of the period, with the ultimate destination being foreign ports, from the public wharf which is located on the river side of the flood walls. During the period 1937 to 1946 petroleum products constituted about 84 percent of the total commerce carried on the river below Hartford, and coal about 15 percent. These commodities are shipped to the river principally from the ports of New York and New Haven. There has been no general freight or passenger boat service, except ferry, on the river since 1931.

VESSEL TRAFFIC

57. The use of the river below Hartford by commercial boats in 1947 is shown by the following table. Data on 1948 vessel movements are not available.

TABLE NO. 2 - TRIPS AND DRAFTS OF VESSELS

	UP-BOUND				DOWN-BOUND			
DRAFT IN FEET	STEAMERS	MOTOR VESSELS	BARGES	TOTAL	STEAMERS	MOTOR VESSELS	BARGES	TOTAL
14-16	2	456	444	902				
12-14		11	170	181		16	10	26
10-12		7	3	10		25	10	35
8-10		2	7	9		172	11	183
6-8			1	1		168	4	172
4-6		30,410	30,410	60,820		30,437	30,426	60,863
2-4		16,644	16,645	33,289	2	16,712	17,219	33,933
TOTAL	2	47,530	47,680	95,212	2	47,530	47,680	95,212
TOTAL net registered tonnage	2,534	702,676	1,260,661	1,965,871	2,534	702,676	1,260,661	1,965,871

Notes: Trips of vessels with 4-6 foot draft include 30,410 trips of ferry crossing river at Haddam.

Trips of vessels with 2-4 foot draft include 16,644 trips of ferry crossing river at Rocky Hill.

In addition to the commercial vessels operating on the river there are about 500 pleasure craft ranging in length up to 40 feet based there. Throughout a period of about four months of the year these boats navigate extensively on the river. Numerous transient boats also cruise in the river, particularly in the lower reaches.

58. No commercial vessels use the river above Hartford. However, there are about 75 pleasure craft ranging in length up to 40 feet based there. These craft cruise extensively on the section above Enfield, but the conditions of the river between the Enfield Dam and Hartford, in which reach the controlling depth in the river at ordinary low water is about 2.5 feet, are such as to discourage navigation in that reach. Records of passages through the locks at Windsor Locks indicate that there were 48 such passages in 1947, all pleasure craft.

PROSPECTIVE COMMERCE BELOW HARTFORD

59. As it is anticipated that the highly developed railroad and highway systems of transportation will continue to carry the miscellaneous commodities required in the area, it may be expected that future commerce on the Connecticut River between the mouth and Hartford will be limited principally to petroleum products, coal, and fertilizer. The transporting of large amounts of manufactured or raw products on the river is not expected. Moreover, further improvement of this section of the river by widening and deepening the channel could not be expected to attract substantial volumes of additional commerce. Such additional traffic as would use the river would result from an increase in the overall requirements of the tributary area for the products carried on the river. Increased activity in the lower river resulting from future commerce destined upstream of Hartford would be a factor in determining the extent of the improvements required in the lower river. A complete discussion of prospective commerce is contained in Appendix V.

60. Oil Pipe Lines As Affecting Future Navigation on the Connecticut River. - It is understood that two concerns in the oil business have been considering the construction of pipe lines between New Haven and Hartford, and possibly Springfield, for transporting petroleum products from the deep-water terminals at New Haven to the Hartford and Springfield areas. One of these concerns has started work on acquiring rights-of-way, but it appears that the line would not be constructed and placed in operation for several years. There has been no direct indication that the other pipe line will be constructed in the near future. Such pipe lines, if constructed, could carry substantial quantities of gasoline, kerosene, and light fuel oils, but petroleum interests state that heavy oils could not be transported economically by pipe lines in this latitude as the oil must be kept warm to aid in its flowing. Therefore, pipe lines would not compete with other means of transportation for carrying heavy oils.

61. Petroleum Products. - The growth of commerce carried on the river in the past is considered to provide a reasonable basis for estimating future commerce. The amounts of petroleum products having water-front destinations on the river between the mouth and Hartford anticipated to be car-

ried on the river in the future are estimated to exceed the average amounts carried annually during the period 1937 to 1941 by 20 percent for gasoline and kerosene, 40 percent for Bunker "C" and other heavy oils, and 70 percent for light fuel oils. This increase is based on the increased demand for petroleum products in the area.

62. Coal. - Most of the bituminous coal now carried on the river is delivered to a steam-electric public utility power plant at Hartford and to a State Hospital at Middletown. It is anticipated that in the future delivery of bituminous coal will be limited to these two installations, and that there will be no change in the annual requirements of the State Hospital. On the basis of the amounts received on the river in the years 1946 and 1947 and allowing for an increase in future receipts, resulting from an increase in the capacity of the utility plant, it is anticipated that 219,000 tons of bituminous coal will be received annually. In the tributary area anthracite is used chiefly for household heating, but at the present time oil is increasing in popularity for this purpose. Therefore, it is considered that anthracite will not be carried on the river in the future.

63. Fertilizer and Miscellaneous. - Prior to about 1942, fertilizer materials were received by water at two mixing plants, one at Portland, Connecticut, and the other at Hartford, Connecticut. Due to the construction of flood-protection works with the resulting difficulty in gaining access to the terminal facilities at Hartford, the latter plant now receives all of its materials by rail and will probably continue to do so in the future. The plant at Portland still receives a large part of its material by water and it is anticipated that its receipts will increase 50 percent over its receipts in recent years. During the years prior to 1941 considerable quantities of other freight were carried on the river. Due to the abandoning of the terminal facilities at Hartford and competition from other methods of transportation, this commerce has largely disappeared. It is anticipated that there will still be a small amount of miscellaneous cargo carried in the future, say 5,000 tons annually.

64. Recreational Boating. - During the next few years it is probable there will be a great increase in the number of pleasure craft based in the river between the mouth and Hartford. It is estimated that this number will amount to at least 25 percent of the number of the present fleet, or 125 boats. In addition to the local fleet there will be many more visiting craft. This increase in the size of the recreational fleet would be due to the general popularity of recreational boating rather than any improvement of the river contemplated in this report.

PROSPECTIVE COMMERCE ABOVE HARTFORD

65. It may be expected that the type of commodities carried in commerce on the river between Hartford and Holyoke would be generally the same as those now transported on the reach of the river between the mouth and Hartford, that is principally petroleum products, coal, fertilizer and fertilizer materials, and in addition some wood pulp. The amount of each commodity can be estimated from the present and future requirements of the tributary area. Information on the total requirements of the tributary area was obtained from statistics published by the Bureau of Mines, United States Department of the Interior, from data furnished by the Special Legislative Commission of the Commonwealth of Massachusetts, and from various local sources. A complete discussion of prospective commerce is contained in Appendix V.

66. Gasoline. - From the total annual consumption of gasoline in Massachusetts obtained from published statistics of the Bureau of Mines, and from the number of motor vehicles estimated to be registered in the tributary area, it is estimated that 448,000 tons are consumed annually in the tributary area. Anticipating an increase of 20 percent in the requirement for gasoline in the next few years, and deducting amounts that may be expected to be brought into the area by other means of transportation, including the existing pipe line from Providence to Springfield, it is estimated that 226,000 tons would be brought into the Springfield-Holyoke area annually by water transportation on the Connecticut River.

67. Light Fuel Oils and Kerosene. - Light fuel oils and kerosene are used in the tributary area principally for domestic heating and other small heating units. On the basis of the total annual consumption of these products in Massachusetts, obtained from published statistics of the Bureau of Mines, it is estimated that 272,000 tons of light fuel oil and 249,000 tons of kerosene are consumed annually in the tributary area. Anticipating an increase of 70 percent in the requirement for light fuel oil and of 20 percent for kerosene in the next few years, and deducting amounts that may be expected to be brought into the area by other means of transportation including the existing pipe line, it is estimated that 262,000 tons of light fuel oil and 146,000 tons of kerosene would be brought into the Springfield-Holyoke area annually by water transportation on the Connecticut River.

68. Heavy Fuel Oils. - Information obtained from the Massachusetts Special Legislative Commission indicates that 241,000 tons of heavy fuel oils, principally Bunker "C", are delivered annually to the area. Anticipating an increase of 40 percent in the general requirement for heavy fuel oils in the next few years, and an additional increase of 50,000 tons that it is estimated would be consumed annually by a steam-electric power plant now under construction, and deducting amounts that may be expected to be

brought into the area by other methods of transportation, it is estimated that 232,000 tons would be brought into the Springfield-Holyoke area annually by water transportation on the Connecticut River.

69. Bituminous Coal. - On the basis of information obtained locally, it is estimated that the industrial plants and utility plants adjacent to the river consume about 400,000 tons of bituminous coal annually. Anticipating an increase of 20 percent in the general requirement for bituminous coal in the next few years and a further increase of 50,000 tons annually to meet the needs of a utility plant now under construction, and deducting coal that will be replaced by the use of natural gas, the total future requirements are estimated to be 363,000 tons. It is anticipated that 50 percent of this amount or 182,000 tons annually would be carried by barge on the river and delivered to water-front terminals.

70. Fertilizer. - Information obtained from the Springfield Chamber of Commerce indicates that, of the 35,000 tons of mixed fertilizers used annually in the tributary area, a large part is manufactured within the area. This fertilizer is manufactured in part from materials brought in by rail and truck. Experience at a plant at Portland, Connecticut, indicates that substantial quantities of these materials may advantageously be transported by water. It is considered that if the more economical water transportation is made available for the raw materials used in the plants above Hartford, the sales by these plants to consumers within the area would be increased. On this basis it is estimated that about 14,000 tons of mixed fertilizer would be produced by the plants served by water transportation, which in turn would require about 6,000 tons of phosphate materials, that, it is anticipated, would be received by water. In addition, it is anticipated that about 2,500 tons of mixed fertilizer would be transported on the river, which amount is the same as that now delivered in the area from the manufacturing plant at Portland, Connecticut.

71. Pulp and Miscellaneous. - Information obtained from the report of the Massachusetts Special Legislative Commission indicates that about 22,000 tons of pulp are consumed annually by two paper mills, one at West Springfield and the other at Holyoke. It is considered that 50 percent of this amount, or 11,000 tons, can reasonably be expected to be received by water if navigation on the river is provided. In addition to shipments of pulp to Springfield and Holyoke, miscellaneous shipments of other commodities amounting to about 4,000 tons might be expected.

72. Recreational Boating. - If a suitable navigation channel below Enfield is provided, many additional pleasure craft would be attracted to the river between Hartford and Holyoke. It is estimated that within a few years after completion of the improvement at least 50 additional boats up to 40 feet in length would be based in the river above Hartford, and

that many transient craft would visit the area annually. It is probable that the transient boats would not increase the number in the area at any one time as many of the local fleet would be absent. Therefore, no additional navigation facilities would be needed to provide for the visiting craft.

73. Summary of Prospective Commerce. - An estimate of the amount of commerce resulting from the combination of (a) modifying the improvement of the river between the mouth and Hartford as considered herein; and (b) improving the river between Hartford and Holyoke is contained in the following table, Table No. 3. The estimate is based on the amounts of commerce discussed in the preceding paragraphs.

(Table No. 3 on following page)

TABLE NO. 3 - PROSPECTIVE COMMERCE ON CONNECTICUT RIVER, FROM THE MOUTH AT LONG ISLAND SOUND TO HOLYOKE, MASSACHUSETTS

	COMMODITY - NET TONS										NUMBER OF PLEASURE CRAFT
	GASOLINE	LIGHT FUEL OILS	KEROSENE	HEAVY FUEL OIL	BITUMINOUS COAL	ANTHRACITE	FERTILIZER AND FERTILIZER MATERIALS	WOOD PULP	MISCELLANEOUS	TOTAL	
Present commerce from mouth to Hartford, Connecticut.	439,000	313,000	161,000	199,000	169,000	20,000	7,000	0	25,000	1,333,000	500
Anticipated increase in commerce having water-front destination between the mouth and Hartford, Connecticut. (percent)	20	70	20	40	Not Applicable	Not Applicable	50	0	Not Applicable		25
Anticipated increase in commerce having water-front destination between the mouth and Hartford, Connecticut.	88,000	219,000	32,000	80,000	50,000	-20,000	3,500	0	-20,000	432,500	125
Total anticipated commerce having water-front destination between the mouth and Hartford, Connecticut	527,000	532,000	193,000	279,000	219,000	0	10,500	0	5,000	1,765,500	625
A part of above anticipated commerce delivered at Hartford water-front has ultimate destination in Mass. If navigation improvement to Holyoke is provided some of this commerce will be carried by water to the Springfield-Holyoke area. Estimated amount of this commerce.	47,000	52,000	46,000	24,000	0	0	0	0	0	169,000	-
Net amount of anticipated commerce destined to water terminals up to Hartford if improvement to Holyoke is provided.	480,000	480,000	147,000	255,000	219,000	0	10,500	0	5,000	1,596,500	625
Anticipated commerce on river between Hartford and Holyoke if navigation improvement is provided.	226,000	262,000	146,000	232,000	182,000	0	8,500	11,000	4,000	1,071,500	125
Total anticipated commerce on river between mouth and Hartford if navigation improvement to Holyoke is provided.	706,000	742,000	293,000	487,000	401,000	0	19,000	11,000	9,000	2,668,000	750

DIFFICULTIES ATTENDING NAVIGATION

74. Commercial navigation interests reported at the first hearing that, due to the narrow width of the channel, navigating the river below Hartford is often difficult, particularly at the bends. Furthermore, the present narrow channel and lack of anchorage or maneuvering areas makes passing difficult. There is insufficient space in which vessels operating on the river can lay over while waiting for the tide or for other purposes. The operators of commercial vessels state that the river is not navigable at night due to insufficient marking. Operators also report that they often must carry only partial loads to reduce the draft of the craft so that they will clear the shoals which usually form each year during the spring freshets.

75. Ice Conditions. - Ice formerly closed the lower river to navigation for short periods in severe winters. However, during the past few years the channel to Hartford has been kept open by the operation of a Coast Guard ice-breaker. Above Hartford the river is subject to severe freezing. Ice floes, brought downstream by high flows, sometimes make navigation below Hartford impossible for a period of up to one month in the spring.

76. Navigation at High Stages. - Navigation on the river below Hartford becomes hazardous when the stage at Hartford reaches 16 feet on the gage. This high water condition usually occurs in the spring, but has and may occur during any month of the year. The construction of authorized flood control reservoirs in the upper Connecticut River basin will result in a material improvement of navigation conditions from Holyoke to the mouth of the river.

PLANS OF IMPROVEMENT BELOW HARTFORD

77. Description of Navigation Features. - Consideration has been given to various requests for modifying the improvements in the river between the mouth and Hartford presented at the time of the hearings. In accordance with the general trend of the suggested modifications, the following plans of improvement have been developed.

Plan I. This plan would provide for increasing the width of the existing 150-foot wide channel between the Lyme railroad bridge and Hartford to a width of 200 feet, with additional widening at the bends; provide for deepening the channel to 16 feet at mean low water throughout its entire length from Long Island Sound to Hartford; provide anchorage areas 600 feet long by 300 feet wide and 16 feet deep at mean low water at Old Saybrook, East Haddam, Haddam, Cromwell, and Rocky Hill.

Plan II. This plan differs from Plan I, in that it would provide for widening the existing channel to 200 feet at the most restrictive locations only, specifically at:

Brockway Bar	Mouse Island Bar
Eddy Rock Shoal	Gildersleeve Island Shoal
Warners Quarry Bar	Pistol Point Bar
Rock Landing Bar	Glastonbury-Two Piers Bar

As in Plan I, it would also provide for additional widening at the bends; provide for deepening the channel to 16 feet at mean low water throughout its entire length from Long Island Sound to Hartford; provide anchorage areas 600 feet long by 300 feet wide and 16 feet deep at mean low water at Old Saybrook, East Haddam, Haddam, Cromwell, and Rocky Hill.

None of the bridges or utilities crossing the river between Long Island Sound and Hartford will need to be modified under the plans of improvement considered herein. No real estate will be required except for spoil disposal areas, and at Gildersleeve Island where widening of the channel will encroach on the island.

78. Water Power and Other Special Subjects. - Matters pertaining to water power, water supply, or flood control are not pertinent to the study of the river below Hartford. The improvements being considered will not increase pollution of the water nor have any adverse effect on wildlife. As the work consists of enlarging the existing navigation channel in the river, the improvement will have no effect on the shore line of the river, except at Gildersleeve Island where the widened channel will require removal of a part of the island. The island is used as a privately-operated feeding area for water-fowl.

PLANS OF IMPROVEMENT ABOVE HARTFORD

79. Description of Navigation Features. - The only specific plans of improvement of the Connecticut River between Hartford and Holyoke for navigation ever suggested by proponents is that designated as "Plan F", in the report of the District Engineer, Providence, Rhode Island, contained in House Document Numbered 165, 76th Congress, 1st session. This plan, designated Plan III herein, together with three alternative plans, designated as Plans IV to VI, inclusive, are considered in this report and are described in the following paragraphs.

80. The plan suggested by the proponents, with minor modifications in channel alinement and with modifications in the design and general arrangement of the dam, power station, and lock at Enfield, is designated herein as Plan III and is described as follows:

Plan III. This plan would provide for a navigation channel generally 100 feet wide and 12 feet deep in earth and increased to 13 feet deep in ledge at a river stage corresponding to 2.0 feet at Hartford, extending from the Steamboat Wharf at Hartford to a point at Holyoke about 3400 feet below the Willimansett Highway Bridge, with a turning basin of the same depth at the upper end 300 feet wide and 1100 feet long and with a vertical clearance of 20 feet above a stage corresponding to a stage of 16 feet at Hartford. This would be secured by dredging an open channel where necessary from Steamboat Wharf a distance of about 1.2 miles to river mile 53.2; constructing a lock and dam, designated in this report as the Hartford Dam, at mile 53.2 to create a pool having a minimum elevation of 8.0 feet above Hartford datum and extending about 11.9 miles to river mile 65.1 and channel dredging within this pool where necessary; constructing a lock and dam, designated in this report as Enfield Dam, at river mile 65.1 to create a pool having a minimum elevation of 38.0 feet above Hartford datum and extending about 20 miles to the tailwater of the existing power development at Holyoke, and channel and turning basin dredging where necessary within this pool; and raising the present bridges where required to obtain the desired clearance. The lock at each dam would be 56 feet wide by 360 feet long and have a depth over the sills of 18 feet. Mooring facilities would be provided above and below each lock. In conjunction with the Enfield Dam a power plant would be constructed for the commercial generation of electricity.

81. Plan IV differs from Plan III in that the Hartford Dam and pool would be omitted and an open navigation channel would be provided from Steamboat Wharf to river mile 65.1, the site of Enfield Dam. The plan is described as follows:

Plan IV. This plan would provide for a navigation channel generally 100 feet wide and 12 feet deep in earth and increased to 13 feet deep in ledge at a river stage corresponding to 2.0 feet at Hartford, extending from the Steamboat Wharf at Hartford to a point at Holyoke about 3400 feet below the Willimansett Highway Bridge, with a turning basin of the same depth at the upper end 300 feet wide and 1100 feet long, and with a vertical clearance of 20 feet above a stage corresponding to a stage of 16 feet at Hartford. This would be secured by dredging an open channel where necessary from Steamboat Wharf, a distance of about 13.1 miles to river mile 65.1; constructing a lock and dam, designated in this report as the Enfield Dam, at river mile 65.1 to create a pool having a minimum elevation of 38.0 feet above Hartford datum and extending about 20 miles to the tailwater of the existing power development at Holyoke, and channel and turning basin dredging where necessary within this pool;

and raising the present bridges where required to obtain the desired clearance. The lock would be 56 feet wide by 360 feet long and have a depth over the sills of 18 feet. Mooring facilities would be provided above and below the lock. In conjunction with the Enfield Dam a power plant with an installed capacity of 32,000 kilowatts would be constructed for the commercial generation of electricity.

82. Plan V differs from Plan IV in that the minimum elevation of the Enfield pool would be 45.0 feet above Hartford datum and that no power plant would be provided, nor would any provision be made for future construction of a power plant at Enfield Dam. The plan is described as follows:

Plan V. This plan would provide for a navigation channel generally 100 feet wide and 12 feet deep in earth and increased to 13 feet deep in ledge at a river stage corresponding to 2.0 feet at Hartford, extending from the Steamboat Wharf at Hartford, to a point at Holyoke about 3400 feet below the Willimansett Highway Bridge, with a turning basin of the same depth at the upper end 300 feet wide and 1100 feet long, and with a vertical clearance of 20 feet above a stage corresponding to a stage of 16 feet at Hartford. This would be secured by dredging an open channel where necessary from Steamboat Wharf a distance of about 13.1 miles to river mile 65.1; constructing a lock and dam, designated in this report as the Enfield Dam, at river mile 65.1 to create a pool having a minimum elevation of 45.0 feet above Hartford datum and extending about 20 miles to Holyoke, and channel and turning basin dredging where necessary within this pool; and raising the present bridges where required to obtain the desired clearance. The lock would be 56 feet wide by 360 feet long and have a depth over the sills of 18 feet. Mooring facilities would be provided above and below the lock.

83. Plan VI would provide the same navigational features as Plan V and in addition a power plant would be provided at the Enfield Dam. The plan is described as follows:

Plan VI. This plan would provide for a navigation channel generally 100 feet wide and 12 feet deep in earth and increased to 13 feet deep in ledge at a river stage corresponding to 2.0 feet at Hartford, extending from the Steamboat Wharf at Hartford to a point at Holyoke about 3400 feet below the Willimansett Highway Bridge, with a turning basin of the same depth at the upper end 300 feet wide and 1100 feet long, and with a vertical clearance of 20 feet above a stage corresponding to a stage of 16 feet at Hartford.

This would be secured by dredging an open channel where necessary from Steamboat Wharf, a distance of about 13.1 miles, to river mile 65.1; constructing a lock and dam, designated in this report as Enfield Dam, at river mile 65.1 to create a pool having a minimum elevation of 42.0 feet above Hartford datum and extending about 20 miles to Holyoke, and channel and turning basin dredging where necessary within this pool; and raising the present bridges where required to obtain the desired clearance. The lock would be 56 feet wide by 360 feet long and have a depth over the sills of 18 feet. Mooring facilities would be provided above and below the lock. In conjunction with the Enfield Dam a power plant with an installed capacity of 42,000 kilowatts would be constructed for the commercial generation of electricity.

SELECTION OF A PLAN OF IMPROVEMENT

84. Selected Plan for Improvement between the Mouth and Hartford. - Of the two plans considered for improvement between the mouth and Hartford, Plan I is the better plan in that it will furnish greater safety for river navigation, and considering probable damage to vessels in the restrictive channel considered under Plan II, possibly greater economy in the future. Thus Plan I was selected.

85. Selected Plan for Improvement between Hartford and Holyoke. - Comparative cost estimates show that it would be more economical to dredge an open channel from Hartford to the Enfield Dam than to construct a lock and dam at Hartford. Thus Plan III was eliminated from further consideration.

86. A comparison indicates that the project cost with the crest elevation of Enfield Dam at 45.0 feet would be less than the project cost with the Enfield Dam crest at elevation 39.4 feet because of the large amount of additional channel excavation that would be required with the lower elevation to obtain navigable depths above the dam. Moreover, the benefit-cost ratio for power with the dam having a crest elevation of 45.0 feet is considerably higher than with a crest elevation of 39.4 feet. Thus Plan IV was eliminated from further consideration.

87. A comparison of the benefit-cost ratios for a lock and dam at Enfield having a crest elevation of 45.0 feet for navigation only, and a lock and dam for navigation and power, indicated that a multiple purpose development would have the greater value. Moreover, a multiple purpose improvement would develop the site for maximum water utilization, providing valuable peaking power. Thus Plan V was eliminated from further consideration, and Plan VI selected as the best plan.

ESTIMATES OF FIRST COST

88. Estimates of the first cost of the improvements considered herein have been prepared on the basis of field surveys and investigations, consideration of the engineering and construction problems involved, and current prices for the various types of work involved. Owners of bridges and utilities were consulted regarding necessary modifications of their structures. The United States Coast Guard was consulted regarding the cost of modifying and establishing aids to navigation. All estimates of first cost are based on price levels prevailing in 1949. Detailed estimates of cost are presented in Appendices VII to X, inclusive, and are summarized in the following table in which total costs, including allowances for contingencies, engineering and overhead, are shown.

(Table No. 4 on following page.)

TABLE NO. 4 - ESTIMATED FIRST COST OF CONSTRUCTION OF PLANS CONSIDERED

ITEM	IMPROVEMENT BELOW HARTFORD		IMPROVEMENT ABOVE HARTFORD			
	PLAN I SELECTED PLAN Increase channel dimensions from 150' x 15' to 200' x 16'. Widen bends. Provide 5 anchorages 300' x 600'.	PLAN II Increase channel depth from 15' to 16'. Increase channel width from 150' to 200' at 8 locations. Widen bends. Provide 5 anchorages 300' x 600'.	PLAN III Provide 100' x 12' channel, with turning basin at Holyoke. Dam at Hartford, with minimum pool elevation of 8.0. Dam at Enfield with minimum pool elevation of 38.0; power development.	PLAN IV Provide 100' x 12' channel, with turning basin at Holyoke. No dam at Hartford. Dam at Enfield, with minimum pool elevation of 38.0; power development, with installed capacity of 32,000 K.W.	PLAN V Provide 100' x 12' channel, with turning basin at Holyoke. No dam at Hartford. Dam at Enfield with minimum pool elevation of 45.0; no power development.	PLAN VI SELECTED PLAN Provide 100' x 12' channel, with turning basin at Holyoke. No dam at Hartford. Dam at Enfield with minimum pool elevation of 42.0, power development, with installed capacity of 42,000 K.W.
			FEDERAL FIRST COST			
Channel, Anchorage and Turning Basin Excavation	$ 877,000	$ 676,000	$ 5,717,000	$ 8,582,000	$ 4,826,000	$ 6,507,000
Removal of Existing Enfield Dam	0	0	5,000	5,000	5,000	5,000
Mooring Facilities at Locks	0	0	315,000	250,000	250,000	250,000
Bridge Modifications	0	0	154,000	154,000	154,000	154,000
Aids to Navigation	24,000	12,000	568,000	571,000	571,000	571,000
Ice Breaking	0	0	0	0	0	0
Malaria Control	0	0	0	0	0	0
Hartford Dam and Lock -						
Dam	0	0	2,536,000	0	0	0
Lock	0	0	3,434,000	0	0	0
Enfield Dam and Lock Without Power -						
Dam	0	0	0	0	4,263,000	0
Lock	0	0	0	0	3,375,000	0
Enfield Dam and Lock With Power -						
Dam	0	0	4,850,000	4,850,000	0	5,105,000
Lock	0	0	3,519,000	3,519,000	0	3,519,000
Power Plant	0	0	11,287,000	11,287,000	0	14,848,000
Miscellaneous	0	0	212,000	212,000	0	212,000
Real Estate Acquisition and Relocation	0	0	365,000	364,000	448,000	448,000
Total Estimated Federal First Cost of Construction	$ 901,000	$ 688,000	$32,962,000	$29,794,000	$13,892,000	$31,619,000
			NON-FEDERAL FIRST COST			
Utility Modifications	$ 0	$ 0	$123,000	$123,000	$ 0	$ 19,000
Bridge Modifications	0	0	118,000	118,000	118,000	118,000
Total Non-Federal First Cost of Construction	$ 0	0	$241,000	$241,000	$118,000	$137,000
			TOTAL FIRST COST			
Federal First Cost	$ 901,000	$ 688,000	$32,962,000	$29,794,000	$13,892,000	$31,619,000
Non-Federal First Cost	0	0	241,000	241,000	118,000	137,000
TOTAL FIRST COST OF CONSTRUCTION	$ 901,000	$ 688,000	$33,203,000	$30,035,000	$14,010,000	$31,756,000

ESTIMATES OF ANNUAL CHARGES

89. Estimates of annual carrying charges have been prepared on the assumption that all work, except the alteration of highway bridges and certain other obstructive structures, and the provision of certain rights of way, will be accomplished at the expense of the United States. The non-Federal charges will be made up of those resulting from the alteration of highway bridges and other obstructive structures, the provision of certain rights of way, and the loss of taxes on the real estate required for the project. Annual charges were computed on an assumed life of 50 years with interest rates of 3 percent on the Federal part and 3-1/2 percent on the non-Federal part. On the improvement above Hartford, the charges include interest on construction funds for one-half of the estimated three-year construction period. Costs involving operation and maintenance programs are based upon reasonable estimates for the extent of work involved, the method of accomplishing the work and the personnel required. Detailed estimates of annual charges are presented in Appendices VII to X, inclusive, and are summarized in the following table.

(Table No. 5 on following page.)

TABLE NO. 5 - ANNUAL CARRYING CHARGES FOR PLANS CONSIDERED

ITEM	IMPROVEMENT BELOW HARTFORD		IMPROVEMENT ABOVE HARTFORD			
	PLAN I SELECTED PLAN Increase channel dimensions from 150' x 15' to 200' x 16'. Widen bends. Provide 5 anchorages 300' x 600'.	PLAN II Increase channel depth from 15' to 16'. Increase channel width from 150' to 200' at 8 locations. Widen bends. Provide 5 anchorages 300' x 600'.	PLAN III Provide 100' x 12' channel, with turning basin at Holyoke. Dam at Hartford, with minimum pool elevation of 8.0. Dam at Enfield with minimum pool elevation of 38.0; power development.	PLAN IV Provide 100' x 12' channel, with turning basin at Holyoke. No dam at Hartford. Dam at Enfield, with minimum pool elevation of 38.0; power development, with installed capacity of 32,000 K.W.	PLAN V Provide 100' x 12' channel, with turning basin at Holyoke. No dam at Hartford. Dam at Enfield with minimum pool elevation of 45.0; no power development.	PLAN VI SELECTED PLAN Provide 100' x 12' channel, with turning basin at Holyoke. No dam at Hartford. Dam at Enfield with minimum pool elevation of 42.0; power development, with installed capacity of 42,000 K.W.
FEDERAL ANNUAL CARRYING CHARGES						
Channel, Anchorage and Turning Basin Excavation	$ 61,400	$ 40,300	$ 400,200	$ 524,200	$ 305,200	$ 398,000
Removal of Existing Enfield Dam	0	0	200	200	200	200
Mooring Facilities at Locks	0	0	13,300	10,700	10,700	10,700
Bridge Modifications	0	0	6,200	6,200	6,200	6,200
Aids to Navigation	1,200	800	50,500	50,600	50,600	50,600
Ice Breaking	0	0	25,000	25,000	25,000	25,000
Malaria Control	0	0	20,000	12,000	12,000	12,000
Hartford Dam and Lock	0	0	318,400	0	0	0
Enfield Dam and Lock, Without Power	0	0	0	0	455,000	0
Enfield Dam, Lock and Power Station	0	0	1,003,000	1,003,000	0	1,215,000
Real Estate Acquisition and Relocations	0	0	14,200	14,100	17,400	17,400
Total Federal Annual Carrying Charges	$ 62,600	$ 41,100	$1,851,000	$1,646,000	$882,400	$1,735,100
NON-FEDERAL ANNUAL CARRYING CHARGES						
Utility Modifications	$ 0	$ 0	$ 5,500	$ 5,500	$ 0	$ 900
Bridge Modifications	0	0	5,300	5,300	5,300	5,300
Tax Loss	0	0	6,000	6,000	7,000	7,000
Total Non-Federal Annual Carrying Charges	$ 0	$ 0	$16,800	$16,800	$12,300	$13,200
TOTAL ANNUAL CARRYING CHARGES						
Federal Annual Carrying Charge	$ 62,600	$ 41,100	$1,851,000	$1,646,000	$882,400	$1,735,100
Non-Federal Annual Carrying Charge	0	0	16,800	16,800	12,300	13,200
TOTAL ANNUAL CARRYING CHARGES	$ 62,600	$ 41,100	$1,867,800	$1,662,800	$894,700	$1,748,300

ESTIMATE OF BENEFITS

90. Benefits Resulting from Improvement for Navigation below Hartford. - Benefits resulting from further improvement of the river between its mouth, at Long Island Sound, and Hartford, Connecticut, will be derived principally from transportation savings resulting from use of deeper draft vessels and fully loading vessels now in use, and from the general improvement in navigation conditions due to channel widening and provision of anchorages. The only benefits susceptible to monetary evaluation are the savings in transportation charges which would accrue from the transportation of commodities to those concerns which improve their terminal facilities by deepening the berths. The volume of such commodities would amount to about 75 percent of the total carried on the river. These benefits have been evaluated in Appendix VI and are summarized in Table No. 6. In addition, benefits which are not susceptible to monetary evaluation will accrue from the increased safety and convenience that will be afforded navigation.

TABLE NO. 6 - ANNUAL BENEFITS FROM PROPOSED IMPROVEMENT OF NAVIGATION BELOW HARTFORD

Commodity to be Transported on River	Net Tons	Prospective Annual Savings
Petroleum Products		
Gasoline, kerosene, light fuel oil	750,000	$159,750
Gasoline, kerosene, light fuel oil	502,000	None claimed.
Heavy fuel oil	160,000	28,800
Heavy fuel oil	119,000	None claimed.
Bituminous coal	209,000	20,900
Bituminous coal	10,000	None claimed.
Fertilizer and Miscellaneous commodities	20,000	None claimed.
Total Annual Benefits	-	$209,450

91. Benefits Resulting from Improvement for Navigation above Hartford. - The benefits to be realized above Hartford are those associated with the improving of a shallow river to extend navigation in a reach not presently served by water transportation. In new projects of this nature, prior to their actual accomplishment, experience has shown that local interests often fail to visualize the ultimate effect on the area served, and consequently do not properly comprehend the benefits to be derived therefrom. Some of those who presented estimates at the public hearing held April 30, 1947, developed benefits that appear excessively high

due to the over-estimate of quantities involved and the inclusion of commodities which may not reasonably be expected to be carried by water transportation. Estimates were also presented which tended to indicate that no benefits were possible. It is considered that the claims that no benefits would accrue were due in part to misinterpretation of conditions and in part to the use of the then prevailing costs of commodities, labor, and transportation. An analysis of benefits which may be properly expected to be realized through lower transportation costs on commodities to be carried by water is presented in Appendix VI. These benefits are evaluated in consideration of the commodity requirements of the area served, the types of commodities which may be transported on the river, the amounts of such commodities which will continue to be transported by land facilities, the amounts of commodities which will be transported on the river and the difference in transportation costs between water and land systems for the river transported commodities. Experience gained on inland waterways in other locations indicates that benefits will accrue to the producers of commodities and transportation companies, and passed on to the consumers as the result of improved competitive conditions. Although the recreational boating industry did not appear at the hearing to present its case, and benefits to this industry are not evaluated, substantial benefits will also be realized by recreational boating interests through the provision of deep water in the river. The evaluated benefits are summarized in the following table.

TABLE NO. 7 - ANNUAL BENEFITS FROM PROPOSED EXTENSION OF NAVIGATION ABOVE HARTFORD

Commodity to Be Transported on River	Net Tons	Prospective Annual Savings
Petroleum Products		
Gasoline	226,000	$206,100
Kerosene	146,000	134,180
Light Fuel Oil	262,000	272,820
Heavy Fuel Oil	232,000	282,910
Bituminous Coal	182,000	48,230
Wood Pulp	11,000	38,060
Fertilizer	8,500	24,060
Miscellaneous Products	4,000	5,000
Total Annual Benefits	-	$1,011,360

92. Total Navigation Benefits Accruing to the Plan of Improvement. - The total navigation benefits resulting from the plan of improvement to provide navigation from the mouth at Long Island Sound to Holyoke, Massachusetts would be

Reach:	Mouth to Hartford	$ 209,450
Reach:	Hartford to Holyoke	1,011,360
	Total:	$1,220,810

93. Benefits from the Hydroelectric Development at Enfield Dam. - Benefits resulting from the provision of facilities for generating electric power will be derived through the availability to existing power systems in the Connecticut River valley of an additional source of power during periods of peak demand. The benefits will be equal to the monetary value of equivalent power generated by steam in the Hartford area. With a dam having a crest elevation of 39.4 feet, and installed capacity of 32,000 kilowatts, as provided under Plan IV, the annual output is estimated to be 181,000,000 kilowatt hours, after making allowance for losses incurred by existing installations. With a crest elevation of 45.0 feet, and an installed capacity of 42,000 kilowatts, as provided under Plan VI, the recommended development, the annual output is estimated to be 237,000,000 kilowatt hours, after making allowance for losses incurred by existing installations. The power output for Enfield Dam under Plan III, was not computed. On the basis of values assigned by the Federal Power Commission, the total value of the power has been computed in Appendix VI as follows:

TABLE NO. 8 - ANNUAL BENEFITS FROM HYDROELECTRIC POWER DEVELOPMENT

Plan	Crest Elevation in feet	Installed Capacity in Kilowatts	Annual Power Output, in Kilowatt Hours	Annual Value
III	39.4		Not computed	-
IV	39.4	32,000	181,000,000	$1,632,000
VI SELECTED PLAN	45.0	42,000	237,000,000	2,139,000

94. Total Benefits Resulting from the Selected Plan of Improvement. - The total evaluated benefits are summarized in the following table:

TABLE NO. 9 - TOTAL BENEFITS FROM THE SELECTED PLAN OF IMPROVEMENT

Total Navigation Benefits (Paragraph 92)	$1,220,810
Total Power Benefits (Paragraph 93)	2,139,000
Total:	$3,359,810

COMPARISON OF BENEFITS AND COSTS FOR VARIOUS PLANS CONSIDERED

95. The ratio of evaluated benefits to costs which result from the various plans of improvement above and below Hartford are given in the following table:

TABLE NO. 10 - RATIO OF EVALUATED BENEFITS TO COSTS

Plan of Improvement	Estimated Annual Benefits	Total Estimated Annual Charges	Ratio of Evaluated Benefits to Costs
	Below Hartford		
I (PLAN SELECTED)	$ 209,450	$ 62,600	3.3
II	209,450	41,100	5.1
	Above Hartford to Holyoke		
III	Not computed	$1,867,800	-
IV	$2,643,360	1,662,800	1.6
V	1,011,360	894,700	1.1
VI (PLAN SELECTED)	3,150,360	1,748,300	1.8
	Selected Plan - Long Island Sound to Holyoke		
I and VI combined	$3,359,810	$1,810,900	1.9

EFFECT OF PLAN OF IMPROVEMENT ON BRIDGES, UTILITIES, AND OTHER FACILITIES

96. Bridge Modifications. - Of the ten bridges between the Steamboat Wharf at Hartford and Holyoke, modifications to four will be required to provide the vertical clearance of 20 feet proposed in this report. This criterion for vertical clearance was developed from the policy indicated by Congress in Section 1 of the River and Harbor Act of July 3, 1930, which is the authorization for the existing project, and which stated that, "the Bulkley or Memorial Bridge across the Connecticut River at Hartford shall not be disturbed." The maximum clearance under the Memorial Bridge that can be obtained at the highest stage when navigation is feasible is 20 feet. The recommended plan of improvement provides for obtaining the required clearance by raising the obstructing bridges. In addition to raising four bridges, extensive construction is contemplated at and adjacent to the railroad bridge at Warehouse Point. The plans contemplate incorporating the piers of this bridge into the tainter gate pier structures of the dam,

and paving the areas between the piers to eliminate erosion of the foundation by water being discharged through the gate openings. It is probable that some strengthening of the two piers adjacent to the present canal on westerly bank will be required. Pertinent data on the bridges affected and the amount of raising required are given Appendix II, and are summarized in Table No. 11.

97. Utilities Modifications. - None of the overhead utilities and only four of the many submerged utilities, all crossing the river between Hartford and Holyoke, will need to be modified in connection with the recommended plan of improvement being considered. Pertinent data on the utilities affected and the extent of modification required is given in Appendix II, and is summarized in Table No. 12.

(Tables No. 11 and 12 on following page.)

TABLE NO. 11 - BRIDGES AFFECTED BY IMPROVEMENTS CONSIDERED

Distance above mouth, in miles	Name or place and ownership	Use	Type	Horizontal clearances in channel spans, in feet	Clear elevation above Hartford datum, in feet	Amount of raising required under plan of improvement recommended
52.7	Hartford, Conn., N. Y., N. H. & H. R.R. Co.	Railroad	Fixed	125.0	32.0	4.2 feet
64.0	Windsor Locks, Conn., State of Connecticut	Highway	Fixed	143.0	34.3	5.7 feet
65.1	Windsor Locks, Conn., (Warehouse Point) N. Y., N. H. & H. R.R. Co.	Railroad	Fixed	140.0	52.9	None (See paragraph 96)
69.1	Thompsonville, Conn., Hartford County	Highway	Fixed	200.0	62.5	4.3 feet
80.4	Chicopee, Mass., Hampden County	Highway	Fixed	170.0	69.6	0.6 feet

TABLE NO. 12 - UTILITY CROSSINGS AFFECTED BY IMPROVEMENTS CONSIDERED

Distance above mouth, in miles	Location and Ownership	Kind of utility	Use	Depth below mean low water, summer stage	Remarks	Amount of lowering required in recommended plan of improvement
71.5	Agawam-Longmeadow, Mass. Springfield Gas Light Company	6-inch pipe	Gas Transportation	About 13 feet	Laid in 3-foot trench	None
75.2	Agawam-Springfield, Mass. American Telephone & Telegraph Company and New England Telephone & Telegraph Company	3 cables	Communication	About 10 feet - on existing bottom	Upstream side of highway bridge	1.5 feet
76.3	Springfield-West Springfield, Mass. United Electric Light Company	Cables	Power	About 13 feet	Laid in 3-foot trench	None
76.5	Springfield-West Springfield, Mass. Springfield Gas Light Company	8-inch pipe	Gas Transportation	About 13 feet	Laid in 3-foot trench	None

98. Alterations to Existing Structures. - It will be necessary to raise about one-fourth mile of secondary road, located on the east bank of the river about 1.5 miles upstream of the Enfield Dam, which will be subject to intermittent flooding. The raising of the railroad bridge at East Hartford will necessitate the raising of the tracks approaching the bridge.

99. It will also be necessary to relocate or modify the Enfield sewage treatment plant, parts of which are below the elevation of the pool formed by the Enfield Dam considered in any of the plans of improvement.

100. Effect on Use of Industrial Water at Windsor Locks. - The proposed Enfield Dam would require the abandonment of the existing dam approximately three miles upstream and sever the Windsor Locks Canal which is used for the supply of water to six manufacturing plants located along the canal. In accordance with existing law, under the proposed plan for navigation and power, surplus water not in excess of the amount now used for industrial purposes, estimated at 75 cubic feet per second, could be made available for such purposes upon application to meet the needs of the plants now served by the Windsor Locks Canal.

101. Effect of Existing Power Developments. - Losses will be incurred by certain existing power installations utilizing water at the site, of, and upstream from, the proposed Enfield navigation and power development. The loss of power in the various existing developments would be small in relation to the amount of power that would be developed by the proposed Enfield project and has been taken into consideration in determining the power benefits that would be derived from the project.

REAL ESTATE

102. Under the proposed plan of improvement the amount of land required for structures and flowage is as given below, classified as to use. The number and types of buildings affected are also given.

TABLE NO. 13 - LAND AND BUILDINGS REQUIRED

Item	Type of Interest	
	Fee Title	Easement
Woodland and River bank - Acres	203.0	513.0
Agricultural Land - Acres	18.0	107.0
Residential and Cottage Sites - Acres	30.0	42.0
Industrial and Commercial Land - Acres	21.0	0.0
TOTAL LAND - ACRES	272.0	662.0
Residential Units	6	15

DESCRIPTION OF STRUCTURAL FEATURES OF THE RECOMMENDED PLAN OF IMPROVEMENT

103. Description of Enfield Dam, Lock and Power Plant. - The recommended plan contemplates the construction of the Enfield Dam at river mile 65.1. The navigation lock would be just upstream from the Warehouse Point railroad bridge with the approach channel in the lower level passing through the existing navigation span in the bridge, near the middle of the river. The main section of the dam would consist of 9 tainter gates with their piers and operating facilities, located just upstream from the railroad bridge, with the existing bridge piers being incorporated in the gate piers. The power station would be on the westerly side of the river about 400 feet downstream from the end of the railroad bridge. The power intake channel would extend from the dam, under the railroad bridge, and would be confined on the west by high ground on the bank of the river and on the east by a concrete wall extending from the dam to the power station. A depth of 18 feet over the lock sills would be provided to insure 16 foot navigation when required. The principal features of the structures are described in detail in Appendix II and summarized in the following table.

TABLE NO. 14 - DATA ON STRUCTURES IN RECOMMENDED PLAN

Enfield Dam.

Length of non-overflow section at easterly abutment	250 feet
Number of tainter gates	9
Size of tainter gates	66 feet by 28 feet
Elevation of gate sill	20.0 feet
Elevation of crest of tainter gates	45.0 feet
Computed stage of flood equivalent to maximum flood of record	51.6 feet

Enfield Lock.

Size	56 feet by 360 feet
Elevation of top of lock wall	53.0 feet
Elevation of lower sill	16.0 feet
Elevation of upper sill	24.0 feet
Depth over sills	18 feet
Lift	43 feet

Power Installation.

Full Pool Elevation	45.0 feet
Drawdown	3.0 feet
Average head	37.0 feet
Installed capacity	42,000 K. W.
Annual output	247,000,000 K. W. H.

104. Fish and Wildlife Features. - In accordance with the request of the United States Fish and Wildlife Service, fishways will be provided in the Enfield Dam.

105. Malaria Control. - Under each plan of improvement it is proposed to prevent anopheline mosquito production through shore line maintenance methods.

106. Flood Control, Abatement of Pollution, and Erosion Prevention. - Investigations with a view to providing special features for the control of floods, the abatement of pollution, or for the prevention of erosion are not pertinent to this study.

PROPOSED LOCAL COOPERATION

107. Local Cooperation for Improvements below Hartford. - The benefits that would be derived from further improvement of the Connecticut River for navigation from the mouth to Hartford, Connecticut, would accrue to the producers of commodities transported on the river, the transportation companies, and the consumers in the Connecticut Valley, and are, therefore, considered to be general in character. Accordingly, local interests should not be expected to make a cash contribution toward the cost of the improvement.

108. The economical accomplishment of the improvement below Hartford requires that dredged materials be deposited along the banks of the river by hydraulic methods. As there are adequate areas along the river banks which are adjacent to the areas to be dredged and are suitable for the disposal of spoil, local interests should be required to provide spoil disposal areas for initial and future maintenance dredging, or to make a cash contribution (a) equal to the cost to the United States of acquiring disposal areas at the time of the need thereof, or (b) equal to the added cost of employing other than hydraulic dredges for accomplishing the work. In addition to furnishing spoil areas, local interests should also be expected to furnish all land, easements and rights-of-way, necessary for the accomplishing and maintenance of the improvement of the Connecticut River below Hartford, and to relieve the United States from claims for damages, including all such claims arising from fishing interests, resulting from the construction and the improvements.

109. Local Cooperation for Improvements above Hartford. - The benefits that would be derived from the extension of navigation on the Connecticut River from Hartford, Connecticut, to Holyoke, Massachusetts, would accrue to the producers of the commodities transported on the river and the transportation companies, and would be passed on to the consumers in the Connecticut Valley. They are, therefore, considered to be general in character. Accordingly, local interests should not be expected to make a cash contribution toward the cost of extension of navigation to Holyoke. Under

those plans of improvement of the Connecticut River above Hartford which include development of hydroelectric power at the Enfield Dam, the developed power will be distributed throughout the Connecticut Valley by existing electric distribution systems. The benefits that would be derived from this power development would thus accrue to consumers throughout the valley, and are, therefore, considered to be general in nature. Accordingly, local interests should not be expected to make a cash contribution toward the construction of the power development.

110. Physical conditions above Hartford will require that much of the dredged material be rehandled in lieu of disposal directly on the river banks. The dredging to be accomplished lies in part within developed city areas or other river reaches where spoil areas for hydraulically dredged materials are not available near the work or will be difficult to obtain. In other river reaches, the materials to be removed will require the use of bucket dredges, and hence, scow transportation to a disposal area. In view of the foregoing, local interests should not be required to provide spoil areas. As the plans of improvement include the construction of dams and locks and the development of pools, local interests would not be required to provide the lands, easements and rights-of-way necessary for the construction of the improvements. In accordance with the policy derived from the Bridge Act dated June 21, 1940, it is considered that the United States would bear the full cost of the alterations to railroad bridges. All other bridges and other structures, including utilities, which enter or cross navigable waters are subject to the prior rights of navigation. Therefore, in accordance with existing law local interests should bear the cost of modifying any other such bridge, utility or structure which interferes with the improvement for or its use by navigation. Local interests should be required to relieve the United States from all claims for damages, including all such claims arising from fishing interests and from claims for damages to structures within the river or its tributaries resulting from the construction or improvement for navigation.

ALLOCATION OF COSTS

111. Several methods of allocating the initial cost of the proposed improvement from Hartford to Holyoke between navigation and power were considered and the method of alternative justifiable expenditures was selected as the method best suited to the proposed improvement. In this method the costs incurred for items used solely by navigation are allocated to navigation, the costs of those used solely for power are allocated to power, and the costs of items used jointly are allocated to navigation or power in proportion to the alternative justifiable expenditures for the separate purposes. For the alternative justifiable expenditure for navigation, the estimated cost, $14,010,000, of an improvement for navigation only, Plan V, was used, and for power the estimated cost, $21,078,000, of an improvement for hydroelectric power only was used. Allocations of both the first cost and annual charges made on this basis are given in Appendix XI and are summarized in the following table.

TABLE 15 - ALLOCATION OF COSTS - PROJECT, HARTFORD TO HOLYOKE

	First Cost	Annual Charges
Allocation to Navigation	$ 13,406,000	$ 805,300
Allocation to Power	18,350,000	943,000
Total	$ 31,756,000	$1,748,300

COORDINATION WITH OTHER AGENCIES

112. Improvements Between the Mouth and Hartford. - The proposed improvements have been discussed with a representative of the Connecticut State Water Policy and Flood Control Commission, and he is of the opinion that the improvements being recommended will meet the needs of navigation, and that spoil areas would be provided by local interests when required. The Acting Regional Director of the United States Fish and Wildlife Service and the Superintendent of the Connecticut State Bureau of Fisheries and Game have been consulted on matters of interest to them. They note that the improvement will partially destroy a water-fowl resting area on Gildersleeve Island, but are of the opinion that it will not seriously disturb the migration of water-fowl.

113. Improvements Between Hartford and Holyoke. - The proposed improvements have been discussed with representatives of the cities of Springfield, Holyoke and Chicopee. These representatives feel that facilities for navigation on the Connecticut River would be of advantage to their communities. They made no particular comment on features of the plan having to do with the developing of power. While representatives of the Massachusetts Special Legislative Commission were consulted in order to obtain statistical data, they made no comment on the proposed improvement other than what they presented at the hearing.

114. When discussed with a representative of the Connecticut Water Policy and Flood Control Commission, he indicated that the State of Connecticut has no particular interest in navigation above Hartford. He further indicated the proposed developing of power at Enfield would be of value to the State in meeting the overall demand on the existing power systems for electric power.

115. The improvements have also been discussed with the Acting Regional Director of the United States Fish and Wildlife Service, the Superintendent of the Connecticut State Bureau of Fisheries and Game, and representatives of the Massachusetts Department of Conservation, concerning the effect of the proposed improvements on fish and wildlife. All of these agencies requested that fishways be provided at the dam for the passage of migrating fish. The representatives of the Massachusetts interests stated that any substantial increase in the flooding of the flat area near the state boundary, and known as Longmeadow Flats, would be detrimental to the migratory water-fowl that use it as a feeding area. Consideration has been given to these comments in the development of the plans.

116. The District Engineer for the Connecticut District of the Public Roads Administration and the Deputy Commissioner, Connecticut State Highway Department, have been consulted with reference to the possibility of providing for a highway crossing on the Enfield Dam. Each

of these officials have advised that a main highway river crossing is proposed for the general vicinity of Windsor Locks in the long range highway planning program.

DISCUSSION

117. General. - The Connecticut River below Hartford is one of the principal arteries for commerce in the State of Connecticut. The river above Hartford, while passing through a rich industrial and agricultural area extending well into Massachusetts is not fully developed for commercial navigation, though there are some recreational craft that cruise in the area.

118. Existing Commerce. - Below Hartford where a 15-foot navigation channel is maintained, large quantities of oil, substantial amounts of coal and a small amount of other commodities are now carried in waterborne commerce. Most of the coal is delivered at Hartford. The petroleum products are delivered at various points along the river, the principal oil terminals being located at East Hartford and Wethersfield, with other terminals handling a considerable volume at Cromwell and Portland.

119. Desired Improvement. - Navigation interests now using the river desire to have the channel deepened to Hartford so that larger craft can be used and craft that now can only carry partial loads can be used fully loaded. Furthermore, they state that widening the channel will make navigation easier and safer. Anchorage areas are needed in which vessels may lay over while navigating the river.

120. Proponents for improvement to provide navigation facilities as far as Holyoke feel that the tributary areas in Massachusetts will benefit greatly by such an improvement. While not proposing a specific plan of improvement, local interests have generally indicated a desire for a development including hydroelectric power facilities in connection with necessary navigation dams.

121. Proposed Plan of Improvement. - The recommended plan of improvement for the river between the mouth at Long Island Sound and Holyoke, Massachusetts, is believed to meet the needs of navigation and power development in all reaches of the river and was developed from the study of two alternative plans for improvements below Hartford and four alternative plans above Hartford. The recommended plan comprises the study plan below Hartford designated herein as Plan I, and the study plan above Hartford designated herein as Plan VI.

122. The recommended plan provides for widening the 150-foot channel between the Lyme railroad bridge and Hartford to 200 feet, deepening the channel to 16 feet at mean low water throughout its entire length from Long Island Sound to Hartford, and constructing anchorages at five locations.

The existing 300-foot width of the channel between Long Island Sound and the Lyme railroad bridge would remain unchanged. Under the improvement proposed, the increased depth would permit the loading of vessels to deeper draft with resulting savings in the unit costs of transporting the commodities. The proposed anchorages are designed to meet the needs of vessels waiting for tides or laying over for other purposes. The widening of the channel throughout its length would greatly increase the ease and safety of navigating the winding river channel.

123. The recommended plan also provides for a navigation channel 12 feet deep at a river stage corresponding to 2.0 feet at Hartford and 100 feet wide from Hartford to Holyoke with a turning basin of the same depth and 300 feet wide and 1100 feet long about 3400 feet below the Williamsett Highway Bridge. The channel is to be secured by dredging about 13.1 miles of open channel to a dam site and there constructing the Enfield Lock and Dam to create a pool having a minimum elevation of 42.0 feet above the Hartford datum and extending about 20 miles to Holyoke. In conjunction with the dam, a power plant having an installed capacity of 42,000 kilowatts would be constructed for the commercial generation of electricity.

124. For improvements below Hartford Plan I was selected over the alternative plan (Plan II) on the basis of the greater ease and safety to be obtained in navigating the winding river channel. For improvements above Hartford Plan VI was selected over the alternative plans (Plan III, IV and V) on the basis of comparison of costs for open channels and for dams of various heights at several locations, potential power development, and the greater benefits to be derived therefrom.

125. Terminal Facilities. - None of the wharves which now handle the commerce on the river have vessel berths deeper than 15 feet, many of them being less, but it is expected that if the channel is deepened to Hartford as proposed herein, the berths at the existing terminals handling about 75 percent of the present business will be deepened accordingly. Although no firm commitments have been made by prospective users of the proposed waterway above Hartford, it is believed that adequate terminal facilities will be constructed in the Springfield-Holyoke area if the improvement is undertaken.

126. Bridges and Utilities. - Below Hartford there are no bridges which will require modification because of the proposed improvement. Above Hartford there are three highway bridges and one railroad bridge in the reach between Hartford and Holyoke that will require modification to provide the minimum vertical clearance of 20 feet and one railroad bridge that will require modification in connection with the construction of the Enfield Dam. In accordance with the policy derived from the Bridge Act dated June 21, 1940, it is considered that the United States should bear the full cost of the alterations to the railroad bridges. Established policy provides

that obstructive structures, except railroad bridges, in navigable waters must be altered by the owners to meet the needs of navigation when required. Accordingly, the three highway bridges that require raising, that is, those at Windsor Locks, Thompsonville, and Chicopee, should be altered at the expense of local interests.

127. Similarly, the cost of modifying utilities crossing the river or other structures in, under, or over the waterway that interfere with the construction of the navigation improvement should be borne by local interests. Available information indicates that in the entire river only one structure, consisting of three telephone cables crossing the river at Springfield, will require alteration.

128. Possible Highway Crossing over Dam. - In accordance with Public Law 562, 79th Congress, 2d session, engineering studies have been made and indicate that the design of the dam structure could be modified to provide for supporting a highway bridge across the river. This modification would consist in general of altering the design of the gate piers so that they would form the lower part of columns or piers supporting the future highway bridge. The modification in design could be made when construction plans are being prepared and would not affect the hydraulic or navigational features of the dam.

129. Navigation Benefits. - The benefits derived from navigation improvements and which are subject to evaluation would accrue from the resulting lower water transportation cost. Below Hartford these benefits would be derived from the use of deeper draft vessels and the possible full loading of vessels now in use. Above Hartford these benefits would be derived from transporting on the river a portion of certain commodities consumed in the tributary area. In addition to evaluated benefits, other benefits would accrue from the proposed improvement. Below Hartford hazards of navigating a narrow channel would be reduced, while above Hartford recreational boating interests would benefit through the greater depth of water in the river.

130. The evaluated benefits for the improvement below Hartford are based upon the amount of commerce which can be expected to be transported on deeper draft vessels. Above Hartford the commodities that are adaptable to water transportation are, in general, the same as those now transported on the river below Hartford. The volume of waterborne commerce anticipated was estimated from published statistics of commodities consumed and from information obtained locally. The evaluated benefits for the improvement above Hartford would be derived principally from savings resulting from the transportation of petroleum products on the river over other means of transportation.

131. Water Utilization. - It is estimated that the needs of vessels passing through the Enfield lock would be met by providing for an average of 10 lockages per day. Furthermore, it is estimated that an amount of

water equivalent to an average of 125 cubic feet per second would be required for the operation of the locks and fishways and to allow for leakage. Provision could be made for a conduit through the dam for the diversion of water to the existing Windsor Locks Canal for industrial purposes in the amount now used, estimated to be 75 cubic feet per second. Such water would be diverted only upon application of those desiring the water, and the disposal of the water would be in accordance with agreements made at the time. The balance of the river flow would be available for the generation of power at the Enfield Dam where there would be an installed capacity of 42,000 kilowatts.

132. Power Development and Power Value. - The Federal Power Commission has made an investigation of the prospective power market and utilization of the power. The Commission finds that the entire output of the proposed project can be absorbed by 1955, or earlier, by existing public utilities in the vicinity. The Commission estimates the value of capacity and energy at the proposed installation at $23.95 per kilowatt of capacity, and 4.78 mils per kilowatt-hour of energy, and recommends operation of the plant over a 12-hour peak-load period during low flow in conjunction with other peak-load plants in the system, the base load being carried as at present by steam plants.

133. Under the proposed plan there would be an installed capacity of 42,000 kilowatts with a maximum capacity of 48,000 kilowatts. This capacity was selected from consideration of (a) low flow during the critical-flow period which occurs in September and October; (b) low flow during the critical-load period in December; (c) flood flow during the December critical-load period causing reduced head and plant capacity; and (d) navigation requirements which make it desirable to keep the velocity in the navigation channel less than 3 feet a second and utilize a minimum drawdown. The energy available is estimated at 237,000,000 kilowatt-hours annually after making allowance for losses incurred by existing installations. Using energy and capacity values based on the cost of an equivalent steam plant in the Hartford area, the value of the power installation is estimated at $2,139,000 annually.

134. Informal discussions with representatives of power companies operating in the area indicate that some of the companies are interested in purchasing the power for distribution and sale through their existing systems.

135. Although physical damage to existing water power installations at Windsor Locks, Holyoke, and Chicopee will be incurred, it is noted that there is no legal basis for compensation by the United States for such damage.

136. Summary. - The benefits that would accrue from the improvement of the Connecticut River between its mouth at Long Island Sound and Holyoke for navigation and power are sufficient to warrent its construction, and are of such general character that the construction cost should be borne by the United States, provided, local interests meet certain requirements of local cooperation.

CONCLUSIONS

137. In view of the volume of commerce that it is anticipated will be carried on the river and the savings in transportation costs that would accrue, further improvement of the Connecticut River from its mouth at Long Island Sound to Holyoke, Massachusetts, is warranted. In view of the anticipated need for electric power in the area in the future, and the relatively low cost with which it could be produced in a plant constructed in conjunction with the proposed dam at Enfield, the construction of a power development in connection with the navigation improvement is warranted.

138. The improvements proposed consist of

a. Widening the 150-foot portion of the existing channel below Hartford and deepening the channel below Hartford for its entire length;

b. Providing five anchorage areas below Hartford in which vessels can lay over while navigating the river;

c. Providing navigation channel 12 feet deep and generally 100 feet wide between Hartford and Holyoke with a turning basin at Holyoke. Later deepening to 16 feet could be undertaken when required.

d. Constructing a dam at Enfield Rapids having a crest at elevation 45.0 feet with a lock 56 feet wide by 360 feet long. A depth of 18 feet over the lock sills would be provided to insure 16 foot navigation when required;

e. Constructing a power plant with installed capacity of 42,000 kilowatts at the proposed dam.

Water for industrial uses could be made available in an amount not in excess of 75 cubic feet per second.

139. The benefit-to-cost ratio of 1.9 to 1 for the entire improvement indicates that the project is economically justified. The estimated cost of construction of the part between the mouth of the river and Hartford is $901,000, and of the part between Hartford and Holyoke is $31,756,000, or a total of $32,657,000, including local cooperation.

140. Local interests should be expected to provide spoil disposal areas needed for the work below Hartford and to modify at their own expense those bridges and other structures, except railroad bridges, that would be obstructive to navigation. The estimated cost of modifying the obstructive bridges and structures is $137,000.

141. It is anticipated that construction of the improvement would take three years. If the project is authorized, funds for the Corps of Engineers work should be appropriated over a period of three fiscal years as follows:

First Fiscal Year	$16,234,000
Second Fiscal Year	9,851,000
Third Fiscal Year	5,840,000
TOTAL	$31,925,000

142. The project lends itself to stage construction: the improvement below Hartford and the improvement above Hartford. The improvement above Hartford may be further divided into initial construction of navigation features only, with provision being made in the construction of the Enfield Dam for future power installation or for the initial development for power at the Enfield Dam with later development for navigation between Hartford and Holyoke.

RECOMMENDATIONS

143. It is recommended that the existing navigation projects for Connecticut River below Hartford and Connecticut River above Hartford be combined into one project and that they be modified to provide:

a. A navigation channel 16 feet deep at mean low water, 300 feet wide from Long Island Sound to the Lyme railroad bridge about 3.4 miles, thence 200 feet wide to Hartford with additional widening at the bends, thence generally 100 feet wide and 12 feet deep at river stage, corresponding to 2.0 feet at Hartford, from Hartford to Holyoke, with a turning basin at the upper end and with a vertical clearance of 20 feet above a stage corresponding to 16.0 feet at Hartford, a total distance of 84 miles;

b. Anchorage areas 16 feet deep at mean low water and 600 feet long by 300 feet wide at Old Saybrook, East Haddam, Haddam, Cromwell, and Rocky Hill;

c. A dam at Enfield Rapids to form a pool with elevation 45.0 feet above Hartford datum, when full;

d. A navigation lock 56 feet wide by 360 feet long in the dam with a depth of 18 feet over the sills.

e. A hydroelectric plant with installed capacity of 42,000 kilowatts at the dam;

f. For the diversion of water not in excess of 75 cubic feet per second for industrial uses.

all as described in this report, at an estimated cost of $31,925,000 for new work exclusive of financial loss incurred by existing power installations above Hartford, and excluding costs to other Federal agencies and local interests. The cost of annual maintenance and operation is estimated to be $426,500. The modifications recommended for the part of the project below Hartford shall in no way affect any part of the existing project not specifically mentioned.

144. Modification is recommended subject to the conditions that local interests:

a. Provide spoil disposal areas for initial and future maintenance dredging of the part below Hartford, or make a cash contribution equal to the cost to the United States of acquiring disposal areas at the time of need thereof, or equal to the added cost of employing other than hydraulic dredges for accomplishing the work;

b. Furnish free of cost to the United States all land, easements and rights-of-way necessary for the accomplishment and maintenance of the improvement of the Connecticut River below Hartford;

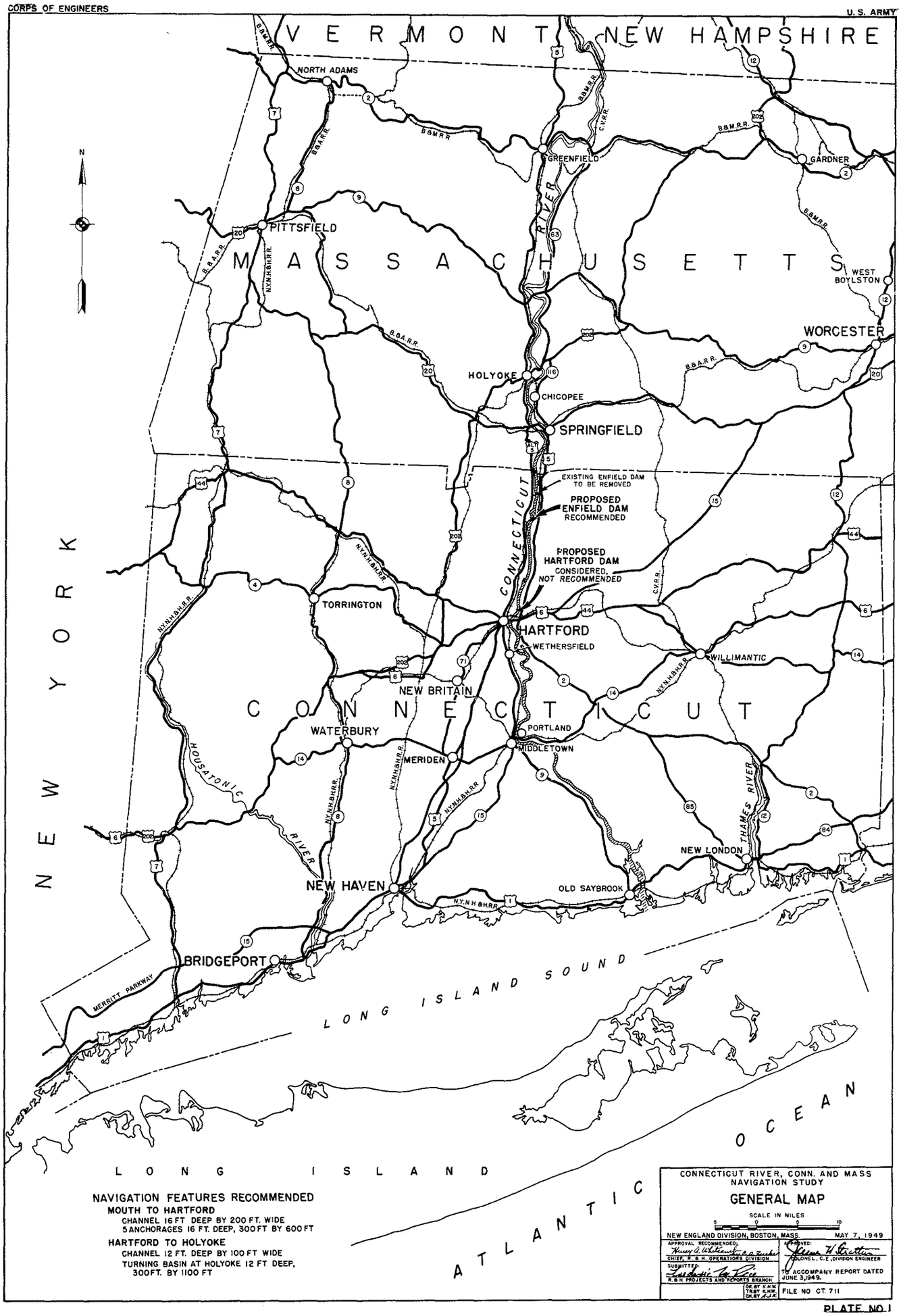
c. Hold and save the United States free from claims for damages resulting from the construction and the improvements below Hartford, including all such claims arising from the fishing industry; from claims for damages to structures within the river or its tributaries and those arising from fishing interests, resulting from the construction or improvement for navigation above Hartford.

JAMES H. STRATTON
Colonel, Corps of Engineers
Division Engineer

4 Inclosures
Plates No. 1 to 4.

CORPS OF ENGINEERS

U. S. ARMY



NAVIGATION FEATURES RECOMMENDED

MOUTH TO HARTFORD

CHANNEL 16 FT DEEP BY 200 FT. WIDE
5 ANCHORAGES 16 FT. DEEP, 300 FT BY 600 FT

HARTFORD TO HOLYOKE

CHANNEL 12 FT. DEEP BY 100 FT WIDE
TURNING BASIN AT HOLYOKE 12 FT DEEP, 300 FT. BY 1100 FT

CONNECTICUT RIVER, CONN. AND MASS
NAVIGATION STUDY

GENERAL MAP

SCALE IN MILES 0 5 0 5 10

NEW ENGLAND DIVISION, BOSTON, MASS. MAY 7, 1949

APPROVAL RECOMMENDED:
CHIEF, R. & H. OPERATIONS DIVISION

APPROVED:
COLONEL, C.E., DIVISION ENGINEER

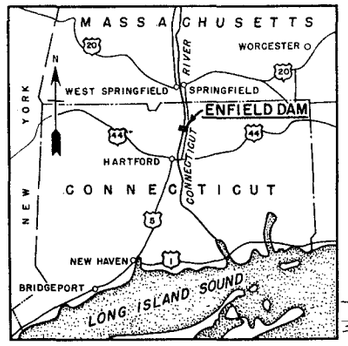
SUBMITTED:
R. & H. PROJECTS AND REPORTS BRANCH

TO ACCOMPANY REPORT DATED JUNE 3, 1949.

DR. BY K.M.W.
TRAY. K.M.W.
CH. BY J.J.K.

FILE NO CT 711

PLATE NO 1



LOCATION MAP

SCALE
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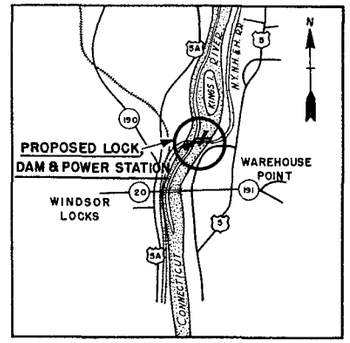

VICINITY MAP

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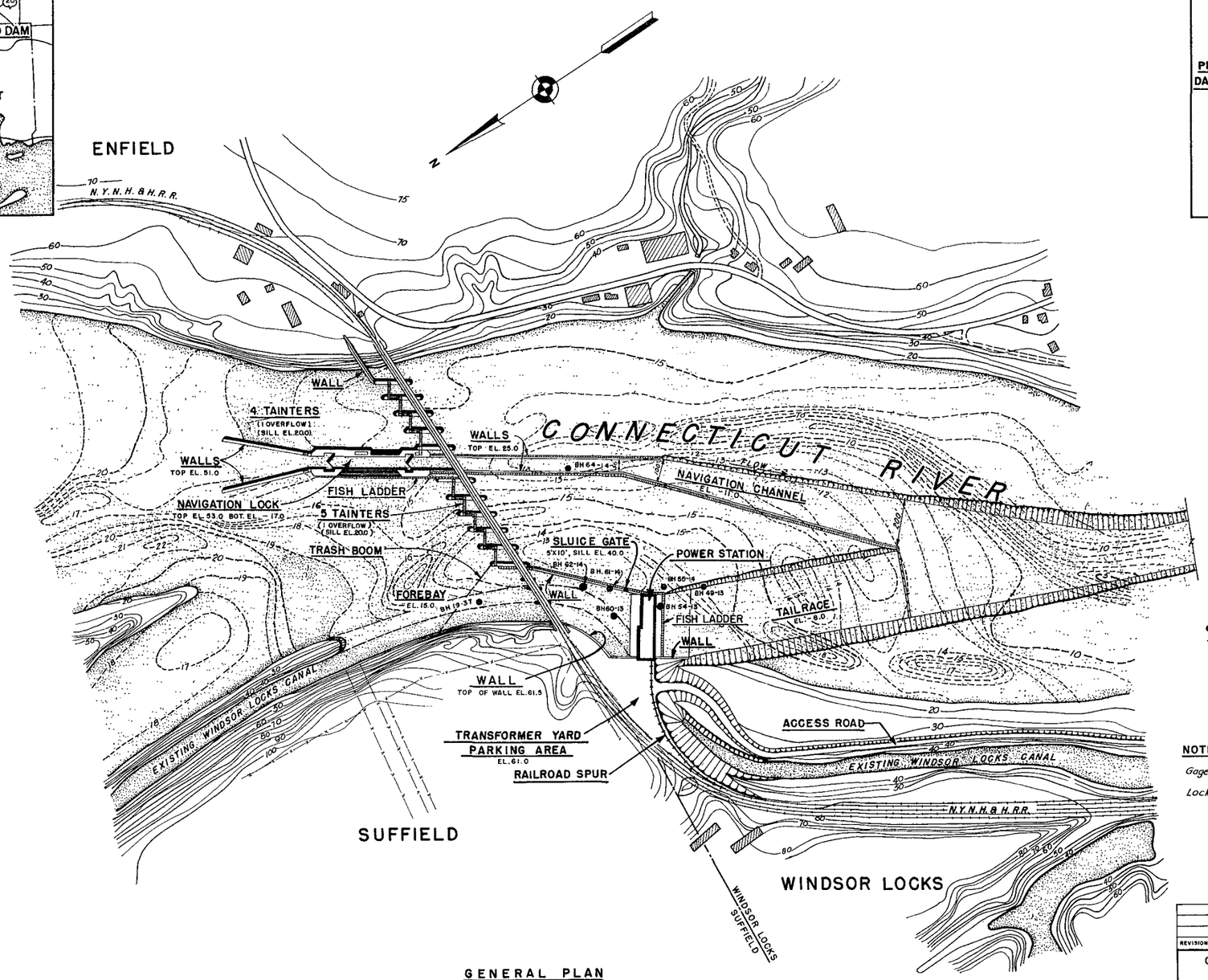


GENERAL PLAN

SCALE: 1" = 200'
200' 0 200' 400'

LEGEND

BH 49-13 Bore Hole
River Bed Contours

NOTES

Elevations refer to Zero of Hartford Gage which is 0.55' below Mean Sea Level Datum. For Log of Borings and details of Dam, Lock and Power Station, see Plate No. 3.

REVISION	DATE	DESCRIPTION	BY

CONNECTICUT RIVER, CONN. AND MASS.
NAVIGATION STUDY

ENFIELD LOCK, DAM & POWER STATION

IN 1 SHEET SCALES AS SHOWN

NEW ENGLAND DIVISION, BOSTON, MASS. MAY 6, 1949.

APPROVAL RECOMMENDED:
CHIEF OF ENGINEERING DIVISION

APPROVED:
COL. C.E. DIVISION ENGINEER

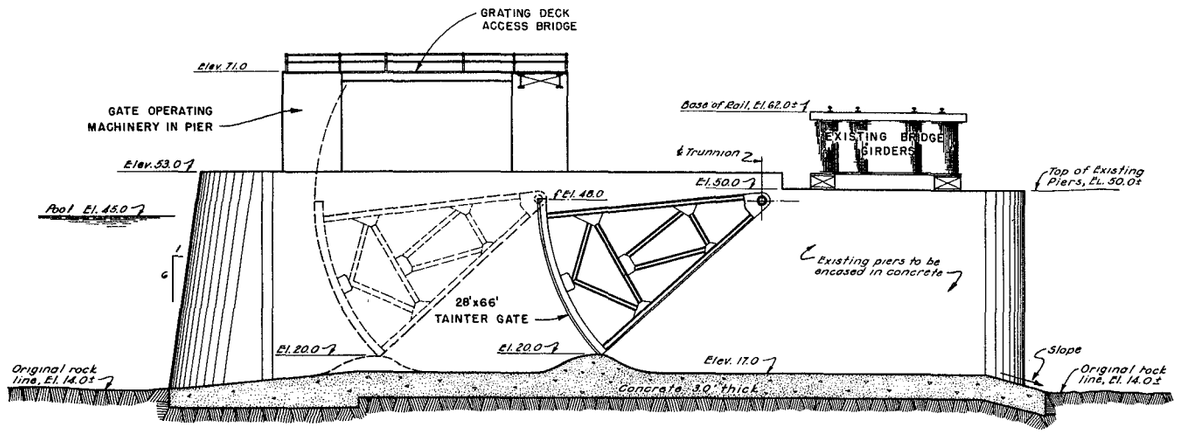
SUBMITTED:
CHIEF OF CIVIL WORKS BRANCH

TO ACCOMPANY REPORT DATED JUNE 3, 1949.

DR. BY: R.S.M.
TR. BY: A.J.H.
CK. BY:

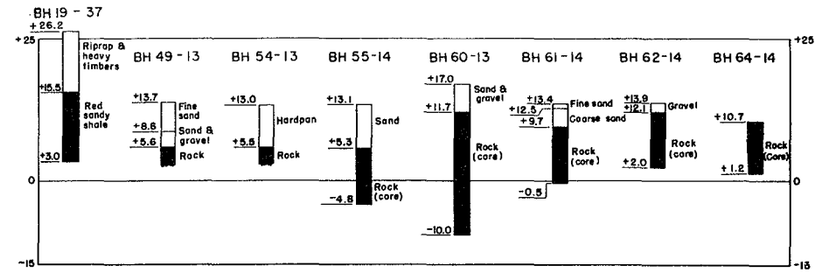
FILE NO. CT. 712

PLATE NO. 2



SECTION THRU TAINTER GATE

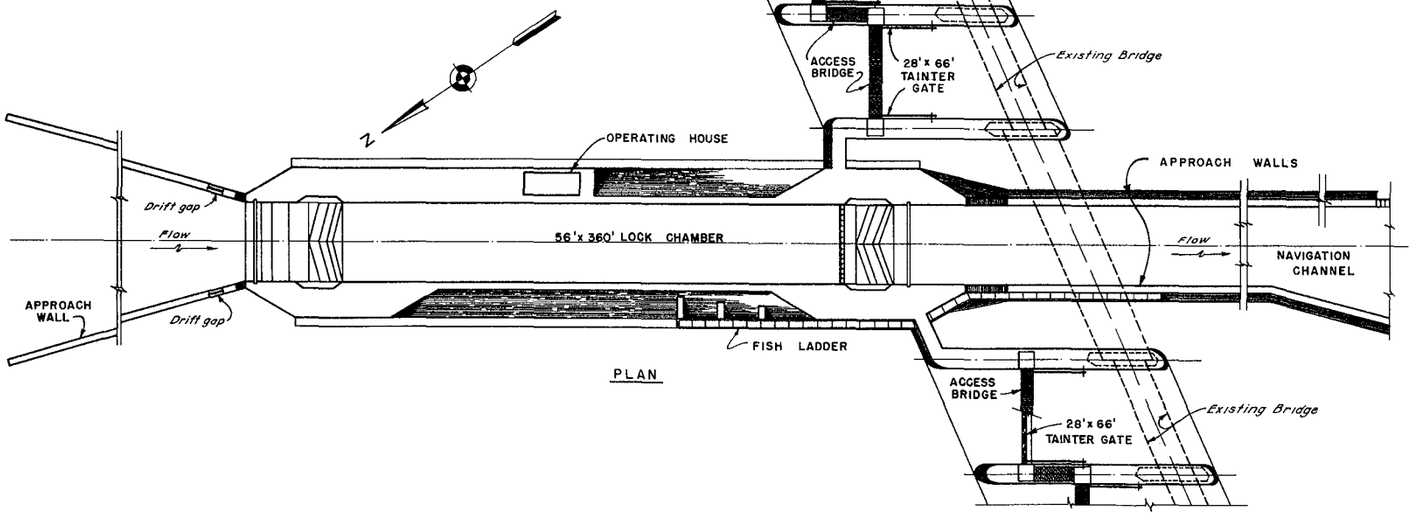
SCALE - 1"=10'



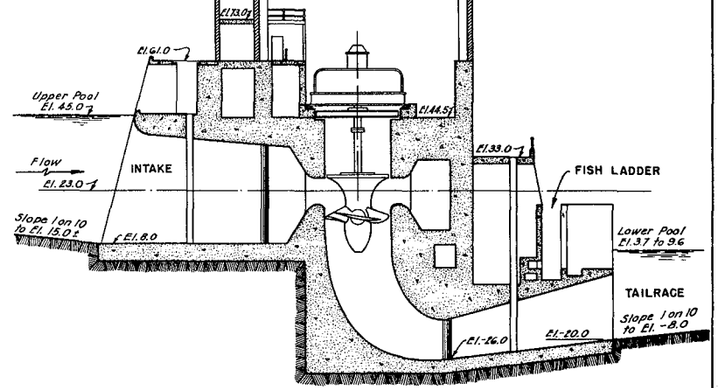
SUBSURFACE INVESTIGATIONS

VERT. SCALE: 1" = 10'

10' 0 10' 20'



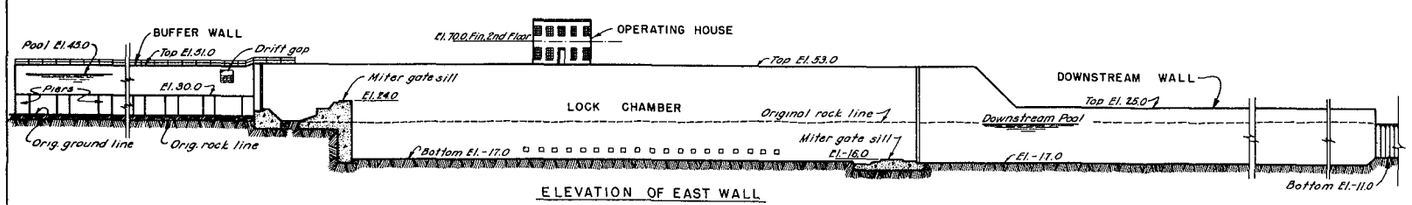
PLAN



SECTION THRU POWER STATION

SCALE: $\frac{1}{16}$" = 1'-0"

16' 0 16' 32'



ELEVATION OF EAST WALL

LOCK

SCALE 1" = 40'-0"

40' 0 40' 80'

REVISION	DATE	DESCRIPTION	BY

CONNECTICUT RIVER, CONN. AND MASS.
NAVIGATION STUDY

DETAILS
ENFIELD LOCK, DAM & POWER STATION

IN 1 SHEET — SCALES AS SHOWN

NEW ENGLAND DIVISION, BOSTON, MASS. MAY 6, 1949.

APPROVAL RECOMMENDED:
John S. Allen
CHIEF OF ENGINEERING DIVISION

APPROVED:
James H. Stratton
COL. C.E. DIVISION ENGINEER

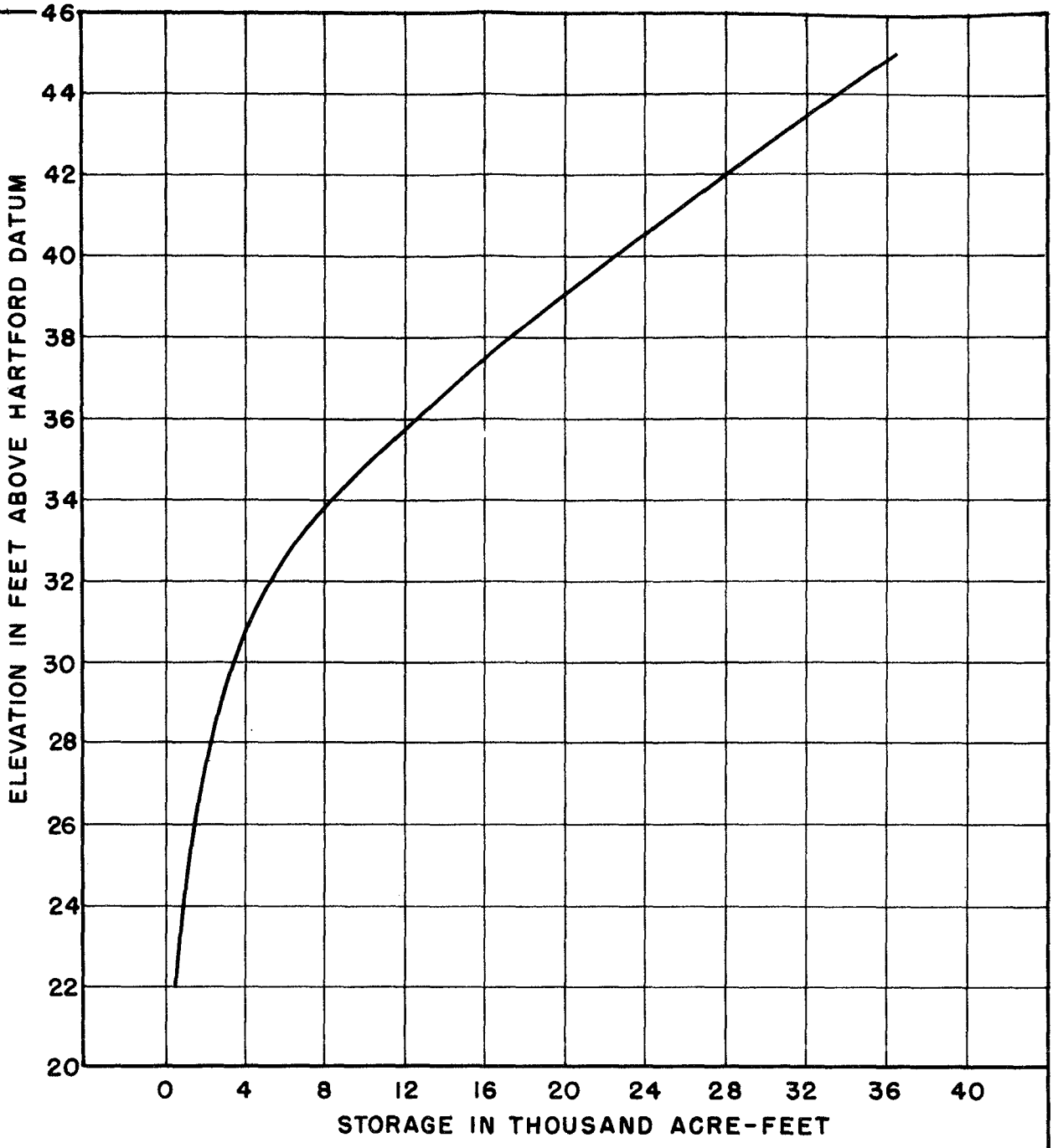
SUBMITTED:
H. J. Hoffpauir
CHIEF OF CIVIL WORKS BRANCH

TO ACCOMPANY REPORT DATED JUNE 3, 1949.

DR. BY: W.A.S.
TR. BY: G.F.B.
CK. BY:

FILE NO. CT. 713

PLATE NO. 3



CONNECTICUT RIVER, CONN. & MASS.
NAVIGATION STUDY

STORAGE CURVE
FOR
PROPOSED ENFIELD DAM

NEW ENGLAND DIVISION, BOSTON, MASS.
MAY 6, 1949.

TO ACCOMPANY REPORT DATED
JUNE 3, 1949